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LIEUTENANT-GENERAL Sir DANIEL LYSONS, K.C.B., Quartermaster-General, in the Chair.

THE MILITARY ASPECT OF CANADA.

By Lieutenant-Colonel T. B. STRANGE, R.A., Dominion Inspector of Artillery.

"THERE is nothing like leather" was the advice of the tanner to his beleaguered compatriots; there is nothing like paper, in any form except dollar bills, would appear to be the opinion of the people of Canada, judging by their representatives. The Parliamentary Vote for military purposes has been steadily diminishing for some years past, while the military literature has been as steadily increasing from responsible as well as irresponsible sources. The defence of Canada has been amply ventilated and the best possible advice given, from the date of the first Militia Bill, originated by the gallant Officer now in the chair, the excellence of which was proved by the defeat of the Government supporting it, while its principal provisions were adopted by their successors. Sir W. Jervois and Colonel Fletcher also planned a complete system of defence.

To General Sir Patrick MacDougal, when Adjutant-General of Militia, is mainly due the localization of militia in military districts, as it still exists in Canada. The Gunnery Schools were formed under Colonel R. Ross when Adjutant-General of Militia, while the Military College under Lieutenant-Colonel Hewitt, R.E., has been developed during the command of Lieutenant-General Sir Selby Smyth, whose annual reports have been most complete and detailed, and replete with excellent suggestions, while the present Adjutant-General, Colonel Powell, a Canadian Officer of long experience, is familiar with all practical details of the department. What need then that I should add to the paper bulwarks of Canada, to which I regret to say I have already contributed with but little result? I do so only by request, for the information of the members of this Institution. The subject divides itself into five heads:—

- 1st. Strategic Geography of Canada.
- 2nd. Militia, Active and Reserve.
- 3rd. Permanently Embodied Militia and Educational Establishments, *i.e.*, Schools of Gunnery and Royal Military College.
- 4th. Armament and Supply.
- 5th. Canadian Contingent for Imperial Service and Military Colonization.

Part I.—STRATEGIC GEOGRAPHY.

Before deciding on what are the strategic points of most importance, and the measures that should be adopted for defence, it is necessary to consider what aggressive operations an enemy would probably undertake, and the natural base and lines of his operations, as well as our own facilities for concentration. I have not taken note of the wilderness between Lake Superior and the Pacific; as it can scarcely be said to contain a military objective, an army could not exist in it, and in any case we could not defend it, unless the Canadian Pacific Railway is constructed. From the North Pole we need fear no aggression, our brave Canadians would find only allies in the resistless cohorts of Field-Marshal Frost as they sweep across the desolate plains to meet the southern invader; unfortunately our flanks are not so secure, resting on Atlantic and Pacific seaboard, for though Britannia may be said in music-hall parlance to rule the waves, we cannot entirely imagine ourselves to have a monopoly of the water-ways of the world. Captain Colomb, R.M.A., in the able papers he has from time to time read in this Institution, has only too clearly proved to us that the police of the ocean, as carried out by the swarms of cruisers in the days of Nelson, or by the swift wooden steamers of a later date (which require numerous and secure coaling stations, more especially if coal armour is practicable), must be considered from a very different point of view when the British Fleet consists of our somewhat cumbrously floating castles of iron, the available number of which for Pacific or transatlantic service might be counted on the fingers of one hand.

Pacific Seaboard.

We must therefore consider the high seas as a base of operations common to ourselves and our possible enemies, who have moreover a secondary base on the continent, which we roughly call British North America, *i.e.*, Alaska, the slice with which the one Eagle accommodated the other, perhaps with the prospect of a future carcass in that locality. Our inadequately protected coaling station at Vancouver is much nearer such secondary bases, on the Pacific shore of Asiatic Russia, as well as the harbours of Oregon and California, to say nothing of others along the 600 or 700 miles of coast where we have no foothold, that could be utilized by a *soi-disant* neutral Power, when certain complications have necessitated the concentration of our fleet in eastern rather than western waters.

During a discussion in this theatre, I was asked whether it was the duty of the Canadian or Imperial Government to defend Vancouver's Island and British Columbia, my answer on this point is not of any practical value. I can only tell you what both Governments have done

towards it, and remind you that until the Canadian Pacific Railroad is built, the Canadian Government would have to send from its Store Department at Ottawa or Montreal round by Cape Horn every musket, every pound of powder, and every uniform button required in British Columbia. I fail to see the advantage of the boasted belt of territory that circles the globe if the electric current of Imperial power which is absolutely necessary for Imperial defence cannot freely permeate through it. The completion of the Canadian Pacific railroad is not merely a vital necessity to the integrity of the Dominion, but of the Empire. It is as much an Imperial as a Colonial question. Its completion would be the realization of the dreams of Christopher Columbus, of Vasco di Gama, and the numerous hardy mariners who have tried to force their way to the east by frozen north or south, or sultry tropic exploration. The shortest route from Ireland to Japan by a thousand miles would be the great circle of the globe along which the Canadian Pacific runs. By it will return the costly silks and teas of China, the products of the Spice Islands, of Australia and India, the cotton of Feejee, as well as the grain of the great valley of the Saskatchewan. Without it Canada is a *cul-de-sac*. The struggling nationality resembles a young giant, whose careless parents allowed one nostril to be stuffed up by the loss of the unfrozen seaports of the State of Maine, and now, after giving up Oregon and the San Juan passage, that other Canadian nostril, we are threatened with the secession of British Columbia, which can neither be defended or traded with. Trade is the life-blood of Anglo-Saxon communities, and railroads the arteries. Never having had the good fortune of being permitted to visit the country, as fell to the lot of my assistant inspector, I have carefully read the exploration reports, and I do not believe in insurmountable engineering difficulties. The railroad will yet follow the Indian trail through the Tête Jaune pass, which is only 4,000 feet, half the height of the lowest pass on the United States line. Salmon make their way up to the head-water of the Frazer river; 12 feet is the limit of a salmon leap. The trail of the Indian, the run of water systems, is the natural line of railroads. Three out of four of our explorations have been athwart three ranges of mountains. The following extract from the Militia Report, page 306, will show the action taken by General Selby Smyth, which is, I am informed, to be supplemented by the further Report of an Engineer Officer from England, and a Royal Artillery Officer from Canada:—

Extract of Report on the Site, Construction, and Armament of the Coast Batteries, erected for the Defence of the Harbours of Victoria and Esquimalt, Vancouver Island, British Columbia—during the months of June, July, and August, 1878, by Lieutenant-Colonel D. T. Irwin, Captain Royal Artillery, and Inspector of Artillery.

The following extract from the general instructions received by me on the day of my departure from Kingston, 13th May, 1878, affords sufficient information as to the general nature of the work proposed to be undertaken, together with the limitations imposed as to its extent, viz.:—

"The Dominion Government have given orders for the erection of a battery on McAulay's Point, Victoria, Vancouver Island, for the protection of the entrance to Victoria and Esquimalt harbours respectively.

"Her Majesty's Government has sent orders to supply such guns as may be required from the dockyard reserves at Esquimalt.

"I enclose a plan prepared by Lieutenant-Colonel Blair, R.A. You will observe he proposes a small battery on Victoria Point, and another on Fisgard Island for the better security of both harbours, in addition to that now proposed on McAulay's Point.

"The latter is considered of the chief importance, the other two only subsidiary.

"It is presumed the Royal Naval authorities will take steps to arm Fisgard Island.

"You will use your discretion as to whether McAulay's Point alone or in conjunction with Victoria Point should be armed.

"In this you will be guided by regard to economy combined with efficiency, and the means of manning two batteries.

"A volunteer battery of artillerymen has been ordered to be raised and equipped at Victoria. You will satisfy yourself that means are at hand for instructing the Officers and men and rendering them efficient, and you will assist in doing so if necessary.

(Signed)

"E. SELBY SMYTH,

Lieutenant-General.

"Choice of Sites for Batteries.

"Having placed myself in communication with Captain F. Robinson, Her Majesty's ship 'Opal,' the then Senior Naval Officer on the Station, I made with him and Lieutenant-Colonel Houghton a careful examination of the coast, with a view to determine upon the best sites for defensive works.

"In this important duty I was afterwards assisted by a Board of Officers, detailed for this duty by Rear-Admiral de Horsey, Commander-in-Chief on the Pacific, and composed of Captain Bedford, Her Majesty's ship 'Shah,' Captain Burrowes, R.M.A., and Gunner Lieutenant Lindsay, Her Majesty's ship 'Shah.'

"It may be sufficient here to state that the plans proposed by Lieutenant-Colonel Blair were not found to be practicable, and it was found necessary, in order to defend with the fire of at least one gun all the approaches to both harbours, to place ten pieces of ordnance in position at the sites undermentioned, and arranged as follows:—

" Finlayson Point,	2 64-prs.	R.M.L.
" Victoria	" 2 64-prs.	"
" McAulay's	" 3 7-in. 6½ ton	"
" Brothers Island	1 8-in. 9	"
" and	2 64-prs.	"

The best means for the defence and development of British Columbia, our coal depôts, and the terminus of the Canadian Pacific Railway would I believe be military colonization of the old Roman or

modern Austrian type, which I hope to discuss more fully at the end of this paper.

Let us now consider our left flank.

Atlantic Seaboard.

The second common base of operations against Canada would be the Atlantic seaboard. It is needless to specify the numerous localities round which the struggle of old wars have surged, of which time does not alter the strategic conditions. Along that indented coast (which would still serve ourselves or our neighbours, whichever had the strongest hand uppermost to begin with), vessels like the "Cimbria" could still be fitted out as privateers against our commerce and the unprotected fishing towns of the Nova Scotian, New Brunswick, Prince Edward Island, and Newfoundland coasts. After reading Mr. Brassey's figures, which tell us that Newfoundland alone in 1872 had 10,000 men engaged in the seal fishery, while the value of the fish exported from that island alone amounted to 1,340,000*l.*, one feels tempted to say if they suffer, the verdict will be, "serve them right." But we cannot allow such verdicts to go forth to the world, if there is any real Imperialism left among us. It is to be hoped the hitherto obdurate islanders, than whom Mr. Brassey says there are no subjects of the Crown more loyal or devoted, will round off our transatlantic Dominion by joining it.

Fortunately at Halifax we have retained some of the *ultima rationes regum et populorum*. We need not therefore discuss the defence of this fortress and harbour, which, however valuable in other senses, can in no sense be considered a safe base for operating in the inland defence of Canada, for the Treaty of 1842, which handed over the State of Maine, sends a wedge of territory up to within a few miles of the intercolonial railroad, which a handful of troopers could at any moment render unserviceable in a night, thus cutting off retreat to Halifax or succour from thence to the upper provinces. It is true that detachments were sent from Halifax during the Trent difficulty; but the United States were at that time disunited States. There are, unfortunately, other undefended points on the intercolonial railroad where the destruction of a bridge by the boat's crew of a privateer would stop communication for some time. There formerly existed a Grand Trunk Railway brigade, and if resuscitated (in the Intercolonial) it would be an efficient means of transporting guns in extemporised railway batteries along the coast, fortifying stations, &c. Unfortunately railway *employés* have shown themselves sometimes too ready to join the disturbers of the prosperity of nations. At many points along the coast are small companies of men, more or less trained as garrison artillery, but without efficient guns or earth-work cover.

The blue crosses on the map show the localities where there are such garrison batteries, open crosses, field batteries. Among other important places, the coal mines of Pictou have been included in this partial defence, which it is hoped may grow into something tangible in time.

Under this head the Lieutenant-General Commanding, Sir Selby Smyth, remarks:—

"With regard to the defences of the Atlantic coast, it was recommended that on Partridge Island, in the Bay of St. John, N.B., a battery should be armed with four 7-inch 7-ton rifled guns, and three 64-pounder wrought-iron guns; Negro Point, with two 7-ton and three 64-pounders; Sydney, Cape Breton, two batteries in succession and in support of each other on Chapel and Mines Points, each to have two 7-ton and two 64-pounder rifled guns; and on Edward Point, two 7-ton and two 64-pounders; Prince Edward Island, two 7-ton and two 64-pounder rifled guns on Battery Point; Pictou, N.S., three 7-ton and three 64-pounders on Moodie Point.

"The total cost of these armaments, with 100 rounds of ammunition per gun, was estimated at about 50,000*l.* sterling, subject to certain deductions, according to the defences which might be adopted for Charlottetown and Sydney."

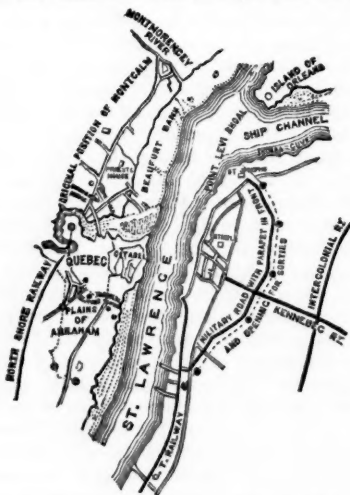
The strategic points on the railway system and on our Atlantic seaboard may be said to be:—

St. Andrew's at the mouth of the James, our boundary river, St. John, N.B., and Fredericton, Halifax, Sydney, Pictou, Charlotte Town, Prince Edward Island, Moncton, Chatham, and Dalhousie.

Quebec, the most important of all, the gateway of the St. Lawrence.

Quebec.

The strategic value of Quebec can scarcely be exaggerated; its fall lost a continent to France, its successful defence by ourselves in 1775 was pregnant with far mightier results to the world at large than we trouble ourselves to think of in these days when a sensational news-



paper article diverts the whole thought of the nation for the usual ten days, to be succeeded by another, and yet another crotchet, to the

apparent exclusion of the long pondered lines of policy on which Empires are built, and from the neglect of which, they crumble to decay; but there are points of vital interest which cannot be discussed by a military lecturer in an Institution like this. Suffice to say, the fall of Quebec would lose us the key of the gate of Canada, and close the only door by which British succour could come to it, or a fleet of gunboats enter its inland waters. In any case, unpleasant as the truth may appear, Quebec remains the only one possible stronghold upon which our militia, if rolled up by an overwhelming force from the west, could retreat and wait for that help which never would be denied from the old country. Meanwhile, a besieger must be kept at arm's length, which can only be done by superior artillery so disposed as to retain its power against attack, if not indefinitely, until such time as relief is at hand.

Inland continental fortresses differ materially from the maritime strongholds of Great Britain. I can recall no instance in our history, since the loss of Calais and Fort Mahon,¹ where the old flag has been lowered at the bidding of a besieger for want of succour from the sea, our great base of operations. Especially does it hold good in the case of a maritime fortress such as Quebec, where "Field-Marshal "Frost" prevents the possibility of a longer investment than five summer months; and even in summer the mighty sweep of the St. Lawrence would render complete investment almost an impossibility to the invader, who could not transport very heavy guns and their enormous weight of ammunition for a long distance over difficult country, with few and bad roads, impassable in the spring and autumn.²

The defender, holding the river within the circle of forts, could throw his whole force on a section of the enemy divided by the St. Lawrence and separated by it from their base of operation and line of retreat. The complete railway systems at the command of Prussia did not enable her to bring heavier guns than 60-pounders in her siege train. There are certain physical data which do not alter, viz., the strength of men and horses, the badness of country roads. Railroads, from the numerous other calls upon them in war, have been found incapable of transporting very heavy artillery. It is hardly to be supposed that the mistress of the seas and her eldest daughter, Canada, whose

¹ Nor do I know of any fortress but Quebec from before whose walls an English fleet has recoiled without success, though not without honour, according to the traditional testimony of the gallant French Canadian, who brought to shore the tattered flag of Admiral Phipps, when asked if it was not heavy, he replied, "*Oui, mon camarade, vous avez raison; c'est chargé de gloire.*" Alas, the response of the stern old De Frontenac when summoned to surrender, "I will give you my answer from the mouth of my guns," would be scarcely possible from the antiquated armament of what was the Gibraltar of America.

² 1875 was the centenary of the winter expedition of Generals Montgomery and Arnold against Quebec; the latter with incredible hardships came through the State of Maine, and, on the death of his colleague, withdrew the shattered remnants of their force. The new detached forts at Levis completely command the intersection of roads and railways east, west, and south, as well as the valley of the Chaudière and Kennebec road, by which Arnold marched, and they occupy the ground from which Wolfe shelled the town.

commercial navy already ranks third among the commercial navies of the world, would permit the siege train destined for the attack on Quebec to be conveyed by sea. The armament, therefore, of Quebec might easily be superior to that brought against it even by hostile ironclads, whose unarmoured decks would be exposed to the citadel fire, which, with the addition of a few torpedoes at the Traverse, would secure the St. Lawrence, if those upon whom the responsibility devolves considered the subject of sufficient importance to warrant a comparatively trifling expenditure, and to prevent, while there is yet time, the erection of buildings which would close the most important lines of fire.

Frontier.

Having considered the strategic conditions with reference to the Atlantic and Pacific seaboard, it remains to consider those of the south with reference to the natural bases and lines of an enemy's operations and the objective he would select for attack. In doing so the question is treated merely in a military and, it is hoped, philosophic spirit, such as cannot give offence to our kinsmen of the great Anglo-Saxon Republic, with whom the most friendly relations exist, but they have not always been able to restrain the lawless bands of Fenians and their sympathizers who have from time to time raided across our frontier; besides, time may change their motto to "*Ex uno plures.*"

The frontier of the Province of Quebec is contiguous to the territory of the United States for a distance of about 450 miles, that is to say, 167 miles of imaginary boundary along the 45th parallel of latitude southward of Montreal and Quebec, running from St. Regis, on the eastern end of Lake St. Francis (an expansion of the St. Lawrence), to the Connecticut river, in the township of Hereford, abutting on the State of New Hampshire. Thence in an irregular line the boundary of the State of Maine follows the high ground which forms the watershed between the Kennebec river, in the United States, and the Chaudière, a tributary of the St. Lawrence, running north-east in accordance with the disastrous arbitration of the Ashburton Treaty of 1842, which brings the territory of the State of Maine to within 25 miles of the St. Lawrence, opposite Rivière-du-Loup. Unfortunately at this point, as before stated, the Intercolonial Railway is close to the frontier, which from this point runs south-east until it meets Dominion territory in New Brunswick. The disadvantage of having a wedge of foreign territory thrust into our own is not altogether so great as might at first sight be anticipated, the character of the country being for the most part rugged, covered with forest, and thinly populated; there are no natural commercial lines, nor any railroads running through it to the north, the watershed north of the St. John's river being close to the St. Lawrence prevents the formation of any long or navigable tributaries to the St. Lawrence; there is, therefore, no natural channel for intercommunication or commerce from the northern angle of the State of Maine into Canada. As military lines of operation always follow natural channels, no invasion of

Canada has ever been attempted from this point, the nearest to it being that of General Arnold, of the United States, in 1775, and he followed the line of the Kennebec and Chaudière rivers. On the other hand, in case of offensive operations from Canada, in the direction of the Penobscot valley, or to seize the triple railroad terminus of Woodstock, Richmond, and Houlton, leading to St. John, N.B., our re-entering frontier would form an advantageous base of operations, backed by Quebec and the St. Lawrence and the Intercolonial Railway. Though the long line of frontier (4,000 miles from ocean to ocean) is apparently attackable at all points, the defence of the country, even with its much smaller population than that of the contiguous States, would, with proper forethought and organization, be by no means so difficult nor impossible a task as some would have us to suppose.

Although, owing to the length and character of frontier, it is quite impossible and not desirable to protect it throughout its whole length, an enemy must capture and establish himself in some vital points before he could obtain any decided military advantage. There are only a few such points. If they were put into and *maintained* in a proper state of defence, with a small body of regular troops as the nucleus of a garrison to be furnished by the local militia, such positions could be held during the five months, in which alone it is possible for an enemy to carry on operations on the large scale necessary to capture them.

Canada is a long strip of communications, its main artery, the St. Lawrence, being the fosse of a natural fortress, open during the summer season (winter operations may be deemed impracticable in this climate)¹ to the gunboats of Great Britain, and to them alone, as long as the fortress of Quebec is kept in a defensive condition. In consequence of the character of the original seigniorial settlement of the Province of Quebec, there are numerous lines of roads running parallel to the St. Lawrence, forming the front and rear of the concessions or seigniorial grants of land.

The Grand Trunk Railway and others on the south shore are now supplemented by railways on the north shore of the St. Lawrence and the Lakes, with their usual telegraphic lines, the whole forming a series of communications which have always enabled Canadian troops to act upon what are practically interior lines, and so concentrate readily upon important strategic points, as was proved in the late Fenian raids.

Successful initiative in war counts for much. Both Great Britain and the United States are forbidden by treaty to build gunboats on the Lakes, but gunboats can and have with the first note of war passed up the St. Lawrence through the Lachine Canal² and on to the Lakes. The Beauharnois Canal on the south shore would pro-

¹ Though the old French Canadian *voyageur* soldiers and Indians often made, during winter, inroads into English Colonies, yet the conditions attending these self-reliant expeditions of a few hardy men hidden by dense forests till they burst upon some defenceless post, are entirely unlike the conditions of modern warfare.

² Now being still further enlarged.

bably be rendered useless at the commencement of hostilities by the United States; but the necessities of commerce, which are with us stronger than any consideration of Imperial defence, point to the probable enlargement of the old canal on the north shore of the Cedar rapids to Coteau landing. There is moreover the second and protected inland navigation route by the waters of the Ottawa to the capital, thence by the Rideau Canal to Lake Ontario and Kingston, which is the other gate opening to us the initiative against the comparatively defenceless emporiums of commerce on Lake Ontario; while the Welland and other canals lead to the more western waters. A counter-initiative from the Atlantic seaboard by the Erie Canal would no doubt be attempted. The Ohio Canal and river debouching at Cleveland is too long a line of counter-current navigation from which to start initiative gunboat attack.

Colonel Fletcher in his paper under this head remarks: "The great trading city of Chicago affords means to the United States, commanding as they do the outlet from Lake Michigan, rapidly to extemporise at the commencement of hostilities, out of their fleet of merchantmen and steamers, vessels of war, sufficient to command Lake Huron, and probably to force an entry into Lake Erie, where they would be met by vessels from Buffalo and other large ports. Thus Ontario would be threatened on its northern, western, and south-western frontier, and would in great measure depend for its defence on a land force, but this land force would run a risk of being isolated and cut off, unless its left flank were protected, and communication maintained with the Province of Quebec, and through that province with the sea. Therefore, *coute qui coute*, the command of Lake Ontario must be secured and maintained. Here Canada is at an advantage, the best harbours being situated on her shores, and the greater number of the steamers trading on the lake being held or manned by Canadians. These harbours, such as Coburg, Port Hope, Toronto, Hamilton, Niagara, and Welland Canal, would require the protection either of permanent or extemporised fortifications."

Kingston.

Kingston should be rendered as secure as possible from capture, and contain a strong garrison capable of protecting the mouth of the Rideau Canal and supporting detachments guarding the Grand Trunk Railway at Brockville and Prescott to Montreal, thus protecting Ottawa, the capital, and the communications to the east.

It is to be hoped that we shall on the Lakes also so far take the initiative recommended by Mr. Brassey, M.P., by encouraging a volunteer naval reserve on Lake Ontario. The common trading steamers and vessels, if armed with an ordinary rifled field gun, would require no extra strengthening, and from the power and range of such guns, would be a powerful means of retaining command of this lake, as well as of the water communications between Kingston and Montreal, and the canals which avoid the several rapids of the St. Lawrence and the Rideau Canal. Troops would be concentrated at the

junctions of railroads and communications from the west, such as Sarnia, Stratford, London, Guelph.

An attack from the west, however, though it might be a good political move, would be bad military strategy, as tending only to roll up the defence along the lines of communication towards the point of support and base of supply, instead of cutting it in two by an attack on the centre.

An Enemy's Central Base—Lines of Operation and Objective.

The enemy's principal base of operations would probably be at Albany, the central point from which natural lines of operation lead direct to Montreal, north-east to Quebec, and westerly to Niagara or Sackets harbour, if Kingston were a secondary objective.

Albany is moreover an arsenal to which there is access by river, road, and railway from all quarters, including the Pennsylvania coal and iron country.

Springfield, a small-arm factory, and Troy, also a manufacturing town, both communicating with Albany and New York, would be subsidiary bases for supplies, which could be poured along the Hudson river and Canal, Lake Champlain, and the roads and railroads all converging on the objective point, Montreal; the strongly fortified position of Rouse's Point, at the head of Lake Champlain on the frontier within 40 miles of Montreal, being the final point of concentration for attack upon Montreal, the defenceless commercial and strategical capital of Canada, to which the Vermont Central and a network of other railroads converge.

Perhaps no better proof of the absolute certainty of Montreal as an objective, and no more complete idea of the inevitable lines of the United States military operation, can be gained than by a study of the twenty-five routes advertised to the Centennial Exhibition of 1876.

A glance at the map before the construction of railways shows that the mountainous regions of the Adirondacs, &c., the Catskills on the west, the White Mountains and the rugged territory of Maine on the east, restricted communications to the channels of the Hudson, Lake Champlain, and the Richelieu Valley, and will explain why history has so often, and will again, repeat itself here as elsewhere. The war-path of the Iroquois and Mohawk was followed by the retaliatory expeditions of the French Canadian *voyageur* soldiers, and then again by British, Colonial, and United States invasions of Canada, down to the last futile effort of a Fenian mob. The tide of war has ever rolled along the channels that nature and art have made it share with commerce and travel. The lately projected Caughnawaga Canal may, it is hoped, never be constructed to admit United States gunboats up the Hudson from the sea, and so complete the communications of Lake Champlain from New York to the St. Lawrence for the enemy who, having seized the Victoria Bridge, and established batteries on the south bank of the river, could bombard the town. The wealthy commercial classes of Montreal would have to pay a very

heavy contribution towards the subjugation of their country. Canada would be cut in two by the capture of Montreal, which is the head of the sea navigation of the St. Lawrence, and the focus of all communications by land and water between Upper and Lower Canada and the maritime provinces; the defence of the country would be severed; Ontario being cut off from Quebec and the maritime provinces, as well as from any aid from Great Britain. An enemy holding Montreal, with its network of communications converging upon it from his basis of supply, could easily maintain himself in the natural fortress island on which the city is built, and contain any force coming from Ontario, hold the communications to Ottawa, the capital of the country, while they proceeded to lay siege to Quebec. The St. Lawrence itself, with its tributary of the Richelieu Canal and the roads and railroads following the line of country in a north-eastern direction, would become fresh lines of communication and supply, to an enemy operating against Quebec. If Quebec, Montreal, and Kingston were put in a proper state of defence, an enemy would be obliged, in aiming at the severance of communication between Ontario and Quebec, the maritime provinces and Great Britain, to carry on three extensive expeditions simultaneously, each involving the necessity of a protracted siege, and considering the short period during which military operations on a large scale can be carried on in this country, there would be every probability of successful resistance. Unfortunately the repeal in 1872 by the Imperial and Dominion Parliament of the Act of Confederation entitled the Canada Defence Act, complicates the defence of Canada. The Act provided for the guaranteed loan of 1,000,000*l.* sterling, for the building of forts round Montreal, as well as the free gift by the Imperial Government of an armament for such forts as might be built at Montreal, also a free gift armament for the Quebec and Levis forts, all of which were declined by the Dominion Government, in favour of a transfer of the guaranteed loan of 1,000,000*l.* to the Canada Pacific Railway.

Central Strategic Points.

After Montreal, Quebec, and Kingston, perhaps the most important point is St. John's, Province of Quebec, the site of the old redoubt commands the railway bridge of the Vermont Central, the junctions from Rouse's Point, Waterloo, and the Passumpsic; the Richelieu river canal, and the roads running north and south, but the advance guard of observation would be at Fort Isle-aux-Noix, close to Rouse's Point and St. Albans railroad junction. "To prevent the enemy from passing vessels down the Richelieu river from Lake Champlain, for the transport of troops, stores, and material for the attack on Montreal, obstructions (torpedoes) should be placed in the river on either side of, and flanked by the fort at Isle-aux-Noix. This work and its garrison would no doubt, being in an advanced and isolated position, be liable to be captured at an early period, but it is considered that the delay it would cause an enemy would more than compensate for the loss that would thereby be occasioned." The garrison in retreating might destroy the Canal Lock in the Richelieu river; Sir

William Jervis also considers Sorel, at the mouth of the Richelieu, an important point. Advanced bodies of militia at Lennoxville and Richmond Railway junction, after keeping the enemy in check, might retire upon Quebec, destroying the railway bridges behind them.

"It is further necessary to provide against attack upon Montreal by a force advancing from the westward, supposing it to have crossed the St. Lawrence, between Lake Ontario and Lake St. Louis. This may best be effected by the construction of works covering the railway bridge near Vaudreuil, at the junction of the Ottawa river with the St. Lawrence. Such works would also act as a *tête du pont*, from under cover of which troops might operate westward; they would, moreover, be on the flank of any force of the enemy advancing against Ottawa. In connection with the defensive position at Vaudreuil, temporary works should be constructed on Isle Perrot, which, if some of the spans of the railway bridge between it and the main land were removed, would form a second line of defence; again, by removing some of the spans of the bridge between Isle Perrot and Montreal Island, a third line might be taken up at St. Ann's."

Between Vaudreuil and the works immediately covering Montreal, Lake St. Louis and the Lachine Rapids would be a sufficient defence; gunboats could be brought into the lake by the Lachine Canal, which is being widened. Any vessels of war that were brought into Lake St. Louis would also be of assistance in the defence of the left flank of the works at Vaudreuil; and if the St. Ann's Lock and the passage near it, between St. Louis and the Lake of the Two Mountains, were made sufficiently large to take such vessels through, they could also aid in the defence of the right flank of those works. They could, moreover, operate in the channel on the north side of Montreal Island, or proceed up the Ottawa and down the Rideau Canal into Lake Ontario.

For the protection of communications by the Lachine Railway and Canal, works should be constructed at Caughnawaga, on the right bank of the St. Lawrence, nearly opposite the junction of the Lachine Canal with Lake St. Louis, and near the terminus of the railway from Plattsburg. These works would also afford the means of throwing a force across the river to act upon the left flank of the enemy operating against Montreal, should circumstances be favourable for such a movement, they could also guard against the entrance to the Beauharnois Canal.

The Island of St. Helen's, upon which rifled guns should be mounted, would form a keep to an intrenched camp covering Montreal and the Victoria bridge. On this island is also the main dépôt for tools, stores, guns, arms, and munitions of war for Montreal and the neighbourhood; it is unfortunately without protection since the barracks formerly occupied by a detachment from the Quebec Gunnery School were burnt. Many thousand stand of rifles, as well as a considerable amount of powder in the magazine, are at the mercy of a handful of raiders, who might carry off the arms and blow up the magazine before the militia of Montreal could be assembled and transported across the river.

The cultivated classes of the United States are friendly in feeling towards Great Britain, and the Canadian population are full of loyalty, which could be at any time rendered active in the defence of the country, provided the principal expense and direction was taken by Great Britain, or the Council of a federated Empire.

Offence.

Often the best defence is offence, but Canada being a colony does not contain within herself the elements necessary to the initiative in war, though her localized militia system and the character of the country, which is a riband of interior lines, land and water communications, would facilitate the concentration and launching of an offensive force which might surprise even 40,000,000 of unarmed people who have hitherto relied upon their ever successful diplomacy. Parliamentary Governments are not, however, suited to a decisive initiative; and when the expenses would have to be shared by the Imperial and Dominion Governments, divided control would be a natural result, rendering initiative perilous if not impossible. Great Britain's natural base of operations (the sea) gives the advantage of enabling her to shift her secondary bases almost at will. A combined military and naval force, therefore, started from Canada at the first declaration of hostilities might, by giving up their communications to the rear, push on to the Atlantic coast as Sherman did, and seize an important seaport, there to co-operate with the British fleet which could support them, and form a fresh base for further operations, while an expedition from India might land a force of British troops and a Sikh contingent on the Pacific seaboard.

Part II.—MILITIA OF CANADA, ACTIVE AND RESERVE.

The Militia Act.

That the Militia Law of Canada is so thorough in its provisions, and that the keystone of the arch of all military systems, *i.e.*, universal liability to military service, is not absent as in those of all other Anglo-Saxon communities, is due to the traditions inherited from the old French *régime*, which were readily followed by the descendants of the "United Empire Loyalists," who found themselves for ever face to face with their more numerous and wealthy kinsmen from whom they had torn themselves, often at the sacrifice of material wealth, for the sake of adherence to those principles and that "Dream of a United Empire" which has not yet been realised, though a century has passed away. The very history of those heroic men has been forgotten, the initials of their distinctive title, U.E.L., bring no very clear picture to the minds of the majority of Englishmen to-day who, let us

hope before it is yet too late, may realise the true meaning of a United Empire.

The theoretically perfect Militia Law of Canada, though it may be an example of military legislation to us at home, yet, like every other law, its practical result depends upon its administration. Instead of quoting the verbiage inseparable from legal documents, I think I cannot do better than give you the condensed *résumé* taken from the Militia Act by Captain J. C. R. Colomb, R.M.A., in his able paper on "The Naval and Military Resources of the Colonies," making some explanations of its practical workings.

Classes of Militia.

"The militia consists of all male inhabitants between the ages of 18 and 60. It is divided into four classes.

"1st Class. Men from 18 to 30 years, who are unmarried or widowers without children.

"2nd Class. Men from 30 to 45, who are married or widowers with children.

"3rd Class. Men from 45 to 60.

"The above is the order in which the male population is called upon to serve.

"The Militia is divided into Active and Reserve.

"Active Militia consists of the Volunteer Militia, the Regular Militia, and the Marine Militia. The Volunteer Militia being composed of corps raised by voluntary enlistment; the Regular Militia of men who have voluntarily enlisted to serve in the same, or who have been balloted² to serve; the Marine Militia composed of seamen, and persons whose usual occupation is upon any steam or sailing craft; the Reserve Militia consists of the whole of the men who are not serving in the Active Militia for the time being. The period of service, in time of peace, in the Volunteer Militia is three years, in the Regular and Marine Militia two years. Men enrolled in the service companies of Regular or Marine Militia during any such two years are not again liable to be taken for drill and training until all the other men in 1st, 2nd, or 3rd Class of the same 'company division' have volunteered or been balloted to serve. No member of a Volunteer Militia corps can, in time of peace, resign under six months' notice."

As the ballot has not been put in force since the existence of the Act, the whole of the Active Militia may be said to be Volunteer Militia, and the term Regular Militia has no special meaning, unless it be applied to the two batteries of artillery, "A" and "B," permanently embodied, one at Kingston and the other at Quebec. They had no existence when the present Act, which did not contemplate the withdrawal of the Imperial troops, was passed. It has therefore no provi-

¹ Published in No. CI of the Journal, page 413, *et seq.*

² Exemption on providing a substitute by payment of 30 dollars.

sions for the maintenance of regular troops, or the three years' period of enlistment now sanctioned for those corps.¹

The Marine Militia unfortunately has no existence beyond the fact of the nautical calling of individuals being noted in the enrolment of the Reserves which takes place every five years. During Fenian raids Militia Artillery, with field guns, were placed on board lake steamers.

"Enrolment.

"Canada is divided into 12 military districts; these are subdivided into Brigade and Regimental Divisions, and again into Company Divisions.

"In each Regimental Division, one Lieutenant-Colonel and two Majors of Reserve Militia are appointed from the residents therein,² all Militia orders and reports are sent to and received through them. In each Company Division one Captain, and one Lieutenant, and one Ensign are likewise appointed to the Reserve Militia. These are responsible by seniority to the regimental staff. Enrolment is carried on by Officers of Company Divisions, and the list is corrected before 28th February every fifth year; from the company returns the regimental rolls are made up. The 'enrolment' for which the company Officers are responsible is 'held to be an embodiment of 'all the Militiamen enrolled, and renders them liable to serve, 'unless exempt by law.'

"Exemptions: Judges, clergy, ministers of religion, professors in colleges and universities, or teachers of religious orders, warden keepers, guards of penitentiaries, officers, keepers, and guards of public lunatic asylums, persons disabled by bodily infirmity, and 'the only son of a widow being her only support.'

"The following, though enrolled, are exempted from active service, except in case of war, invasion, or insurrection. Half-pay Officers of Her Majesty's Army and Navy, sea-faring men, and sailors actually employed in their calling, pilots and apprentice pilots during the season of navigation, masters of public and common schools.

¹ These two batteries, or gunnery schools as they are called, were first formed of Officers and men selected from the Active Militia Artillery. The Officers held no commission except in the corps from which they were taken, and the men were not enlisted except in their original corps; but on entering the schools of gunnery for one year, were re-enrolled for a further period of three years in their respective corps. The serious inconvenience of this course, from the fact of the original corps sometimes becoming non-effective before the period of service in the gunnery schools of Officers and men had expired, left such Officers and men apparently without legal status. This was subsequently remedied by granting commissions to the Officers of "A" and "B" batteries, and enlisting the gunners in those corps.

² It is to be regretted that these Officers of Reserve Militia for the most part have had no practical military training whatever, and have not even passed through the Active Militia. In war they would be of little use in organizing or leading the men they enrol. Their military titles would at best be only a source of confusion. It may be said in favour of the system that it is old, being a relic of the old French feudal system, but it must be remembered that its success depended on the warlike seigneurs who have been improved away. It has no doubt the advantage of facilitating enrolment, and enlisting on the side of loyalty and order some of the influential men of country districts all over the Dominion.

"Her Majesty is empowered by the Act to make such regulations for the enrolment of such horses as may be necessary for the purpose of field artillery and cavalry.

"The oath to be taken by all ranks of Active Militia is simply as follows:—'I, A. B., do sincerely promise and swear that I will be faithful and bear true allegiance to Her Majesty.' It can be administered by the Commanding Officer.

"Balloting.

"When the Active Militia is to be organized for drill or actual service and enough men do not volunteer in any Company Division to complete the quota required from that Division, the men in the 1st class are balloted first; if the number of men required is greater than the whole number in 1st class, then the 2nd class is required to make up the deficiency, and so on through each class; but at no time—says the Act—'shall more than one son belonging to the same family, residing in the same house—if there be more than one inscribed on the militia roll—be drawn, unless the number of names so inscribed be insufficient to complete the required proportion of service men.'"

"Officers; Appointment and Relative Rank.

"Appointments of Officers to the Active Militia are provisional, pending the taking out of a certificate of fitness from one of the military schools of the Dominion.¹

"According to the Act, Officers of Her Majesty's Regular Army are always reckoned senior to Militia Officers of the same rank, whatever be the dates of their respective commissions."²

The Canadian Militia Act also provides that each of the twelve Deputy Adjutants-General of Districts "shall command the Militia in his district."³

The following paragraphs, 35 and 36 (which are difficult to reconcile with the previous mentioned), would imply that the ordinary rule of the senior Officer being entitled to command was intended to hold good, as also the 185th Article of War.

(35). "The relative rank and authority of Officers in the Militia of Canada shall be the same as the relative rank and authority of Officers in Her Majesty's Regular Army; and any body of Militia assembled on parade shall be commanded by the Officer highest in rank then present, on duty and in uniform, or the senior of two or

¹ There are no cavalry or infantry schools; the appointment of Officers of those branches are confirmed by boards of Militia Officers, though a few Officers of cavalry and infantry are occasionally allowed to fill vacancies at the artillery schools where an endeavour is made to give instruction in all arms.

² By a late notification in General Orders of the *Canada Gazette*, Officers of Her Majesty's Regular Army serving with Canadian Militia or Volunteers, are not allowed to avail themselves of their Army rank.

³ But on occasions of emergency, when the troops of one military district have been ordered into another, both Adjutants-General have claimed the command. While in the case of the apprehended riots at Montreal at the funeral of Mr. Guibord, the line between two military districts running through the city, the head-quarters of the troops being at one side, while the cemetery was on the other, the command of the force should have been changed at a certain spot on the line of march.

"more Officers of equal rank; provided that no Officer whose rank is provisional only shall under any circumstances command an Officer of the same grade whose rank is substantive."

(36.) "Officers of Her Majesty's Regular Army shall always be reckoned senior to Militia Officers of the same rank, whatever be the dates of their respective commissions."

"The present law permits the training annually of a number not exceeding 45,000 all ranks. The training period for Active Militia, called out for training, is not to exceed 16, nor to be less than 8 days in any one year."

"Non-commissioned officers and privates of mounted corps receive, for each day's drill of three hours, 75 cents for each horse that has taken part in the drill; and every Officer and man of the Regular and Marine Militia, and the Officers of Reserve Militia, called out for training, receive 50 cents for each day's drill. Payment for drill is made on proof of compliance with regulations touching the drill and efficiency of the several corps."

"The Militia, or any part of it, may be called out for 'actual service,' either within or without the Dominion,¹ whenever it appears advisable to do so by reason of war, invasion, or insurrection, or danger of any of them, and when so called out, it may be placed by Her Majesty under the orders of the Commander of Her Majesty's Regular Forces in Canada, and will be paid at such rates of daily pay as are paid in Her Majesty's Service."

"Officers and men, when called out for actual service, and also during the period of annual training, or during drill or parade of their corps, or as spectators, or while wearing uniform, are subject to the rules and Articles of War, and Mutiny Act, the Queen's Regulations and Orders for the Army, and all other laws then applicable to Her Majesty's troops in Canada, and not inconsistent with the Canadian Act."

"Command in Chief."

"By the 15th section of the British North American Act, 1867, the Command in Chief of Land and Naval Militia was vested in the Queen, to be exercised and administered by Her Majesty personally, or by the Governor as her representative."

"The Minister of Militia is charged with and responsible for the administration of Militia affairs, including all matters involving expenditure, and of the fortifications, gunboats, ordnance, ammunition, arms, armouries, stores, &c."

"The Governor may appoint a Deputy Minister and such other Officers as may be necessary."

"The Adjutant-General of Militia for the Dominion of Canada shall be a person educated to the military profession and who has attained the rank of a Field Officer in Her Majesty's regular Army."

¹ The Militia can be called out in aid of the civil power on a written requisition by the mayor or any two magistrates in any municipality in which a riot takes place, and the Officer in command is to obey such instructions as may be lawfully given him by any magistrate in regard to such riot. A difference of opinion between the magistrates puts the Officer commanding in an awkward position.

"He shall have the rank of Colonel in the Militia and shall be charged, "under the orders of Her Majesty, with the military command and "discipline of the Militia." A Deputy Adjutant-General of Militia is also provided for at head-quarters, as well as a Deputy Adjutant-General and staff for each of the 12 military districts.

Her Majesty may further appoint Staff Officers of the Militia with such rank as from time to time may be found requisite or necessary for the efficiency of the Militia service, but in no case to exceed that of Major-General.

The above is an outline of the legal enactments on which the Militia of Canada rests.

The Militia.

The head-quarters of military districts are marked on the map, also positions of field and garrison batteries and permanent militia garrisons.

Ontario is divided into 4 military districts.

No. 1 Military District comprises Western Ontario, with its head-quarters at London.

Infantry	11 battalions and 2 independent companies.
Cavalry	1 regiment of 4 troops.
Artillery	{ 2 field batteries. 2 garrison batteries.

No. 2 Military District, at the western end of Lake Ontario, with its head-quarters at Toronto.

Infantry	15 battalions and 1 independent company, with mountain guns.
Cavalry	Governor-General's body guard, 2 troops; 1 regiment, 7 troops.
Artillery	{ 3 field batteries. 2 garrison batteries.
Engineers	1 company.

No. 3 Military District, east end of Lake Ontario, with head-quarters at Kingston.

Infantry	10 battalions.
Cavalry	2 regiments.
Artillery	{ 2 field batteries. 4 garrison batteries.

No. 4 Military District, Eastern Ontario, with head-quarters at Brockville.

Infantry	6 battalions and 3 independent companies.
Cavalry	2 troops (Governor-General's Dragoon Guards, 1 troop).
Artillery	{ 2 field batteries. 1 garrison battery.

The Province of Quebec is divided into 3 military districts.

No. 5 Military District, that portion of the western end of the pro-

vince and southern frontier, mainly inhabited by English Canadians; head-quarters, Montreal.

Infantry.....	14 battalions and 3 independent companies.
Cavalry	1 regiment (3 troops), and 5 independent troops.
Artillery ..	{ 3 field batteries. garrison, 1 brigade of 6 batteries and 1 independent battery.
Engineers	2 companies.

No. 6 Military District, head-quarters, Montreal. (French Canadian troops.)

Infantry....	7 battalions and 10 independent companies.
Cavalry	Nil.
Artillery ..	Nil.

No. 7 Military District, with head-quarters at Quebec, mixed English and French Canadian troops, mainly the latter, extends to the Atlantic, along both sides of the St. Lawrence.

Infantry	14 battalions.
Cavalry	1 squadron.
Artillery	{ 1 field battery. 3 garrison batteries.

No. 8 Military District comprises New Brunswick, with head-quarters at Frederickton.

Infantry	5 battalions and 4 independent companies.
Cavalry	1 regiment.
Artillery	{ 2 field batteries. 1 brigade garrison artillery (9 batteries).
Engineers...	1 company.

No. 9 Military District, Nova Scotia.

Infantry	9 battalions.
Cavalry	1 troop.
Artillery	{ 1 field battery. 2 brigades garrison artillery (6 batteries each), and 5 independent batteries.

No. 10 Military District, Manitoba, head-quarters, Winnipeg.

Infantry	2 independent companies.
Artillery	1 field battery.

No. 11 Military District, British Columbia, head-quarters, Victoria, British Columbia.

Infantry	5 independent companies.
Artillery	2 garrison batteries.

No. 12 Military District, Prince Edward Island.

Infantry	3 battalions.
Artillery	4 batteries garrison artillery.
Engineers	1 company.

The battalions consist usually of 6 or 8 companies of 40 bayonets. The number of Officers has lately been reduced to 2 per company, which does not allow of drill being properly carried out with right and left guides.

The cavalry, 40 sabres per troop.

The field battery, 70 gunners, and non-commissioned officers.

The garrison battery, 40 gunners and non-commissioned officers; making a total of about—

Infantry	37,000
Cavalry... ..	1,800
Field artillery	1,350
Garrison artillery.....	3,000
Engineers.....	215

43,365¹

Only about half these numbers have been drilled during the past two years, the Militia estimates having been reduced by about one-half. On this point, and everything connected with his command, Lieutenant-General Commanding Sir Selby Smyth, has furnished a most complete and exhaustive report, which I cannot do better than quote and recommend you to read for further information. He states:²

"When first I came to Canada, I believe the Parliamentary grant for the Militia amounted to about a million and a half of dollars per annum, and with that sum the 42,000 men annually trained in brigade camps for the full period allowed by law. The following and each succeeding year the vote was decreased, until last year it amounted to less than one million dollars, out of which the maintenance of the Royal Military College and the North-West Mounted Police have become a charge upon it. Therefore the paid training of the Militia has been reduced to a minimum, only one-half the force being embodied for twelve days' drill in each year, and such training as that amounts to is almost useless, being really little more than an armed muster at battalion and company head-quarters.

"The Militia grant last year was exactly 931,956 dollars, from which deduct 306,356 dollars for North-West Mounted Police, and 50,000 dollars for the Royal Military College, leaving somewhat more than half-a-million dollars for militia purposes proper, and the supply of all warlike stores.

"The supply of military stores takes a considerable portion of this grant. It comprises clothing for the whole force, which has to be frequently renewed, and for the two gunnery schools, twice a year,³ great coats, rifles and material for their repair, ammunition, field and garrison guns, saddlery, gunpowder, as well as accoutrements and equip-

¹ These numbers of course do not include the Imperial garrisons at Halifax; nor are the two permanent Canadian artillery garrisons of Quebec and Kingston included in the militia strength of the districts.

² *Vide* Report on the State of the Militia of the Dominion of Canada for the year 1878, page 14, *et seq.*

³ One suit of cloth, one of serge, per annum, with an allowance to keep up winter underclothing.

"ments of every description that an army requires. So that in fact, after deducting, besides salaries, pay for drill instruction to Captains, storekeepers, rent for armouries and storehouses, fuel and light, artillery and rifle association allowances, band pay, targets, drill sheds, rifle ranges, and contingencies for general service not otherwise provided for, there remains for the drill pay and incidental expenses attendant on drill and training, only the meagre and insufficient sum of 155,000 dollars, or about 30,000*l.* sterling. This sum is quite inadequate to keep the 42,000 Militia of Canada in a proper state of training and effectiveness, amounting approximately to the annual cost of a single British battalion of the line. What progress can a General Officer make in this case? He can only feel himself a source of disappointment to the excellent and loyal body of Officers and men under his command, who look to him for support."

General Remarks.

Given the every-day life of a people and their physical surroundings, and it is not difficult to form a true estimate of the character of its soldiers, especially when they are a national army and not the product of one or two classes or strata of society. Perhaps the leading characteristic of all Canadians is self-reliance, a splendid military quality, especially in the rank and file during war, but capable of extreme development among the Officers of all volunteer forces even in peace.

Infantry.

The general characteristics of the population of great cities are much the same everywhere. They are more intelligent, but less robust, than the rural population; they readily acquire a military carriage, precision, and smartness in drill; their uniforms are better fitted, their arms and accoutrements in better order, and their comparatively wealthy Officers are willing to assist liberally in producing these results, which, after all, go some way towards real efficiency. But in a serious struggle the backbone of Canada would, I believe, be found in the rural battalions.

A very large proportion of the farming population engages in lumbering during the winter.

He who has lived among these genial stalwart lumbermen, shared their shanty and their bivouac in winter and in early spring, when they drive the logs along the icy torrents and head waters of their wooded wilderness, cannot but be impressed with the belief that he is among Nature's soldiers of the very best type.

Be they English or French Canadian, there is not, I believe, finer stuff for soldiers among any population in the world, while the habits of organization and supply of the various lumber camps at the extremity of long lines of difficult communication are a Quartermaster-General's department in miniature. Again I must quote Sir Selby Smyth for the gist of the whole matter as to the difficulty of training such men under present conditions:—

"Fortunately for the country the battalions are commanded, and

"in general officered, by gentlemen of zealous patriotism and strong military proclivities, and in the various cities they have continued to assemble—their men for unpaid drill as often as possible in the long and unoccupied winter evenings. Therefore city battalions and corps of all arms are in an efficient state, but country battalions are, owing to the absence of such opportunities and facilities, less so. However, they are fairly drilled too. They are fully armed, clothed, and equipped. They are proficient in the use of their rifles, being as a rule capital shots,¹ and a few weeks would suffice to place them creditably in line with any troops.

"The training of rural battalions at company head-quarters for three successive years has not resulted in much good. The majority of the men reside on farms at a distance from their company head-quarters, and when called on to drill they have to give up their day's work and that of their horses, receiving only fifty cents in lieu. Therefore they are naturally anxious to shorten the period by performing two days' drill in one, and so the work is hurried over in a perfunctory fashion; the drill instructor, who draws his forty dollars a year as such, possibly having learnt but little of the rudiments of drill, discipline, or regimental economy. A looseness and laxity of system therefore occurs which does not conduce to the first principles of training a soldier. It has been brought to my notice that rural corps ordered out for training are frequently composed of about one-half recruits, showing that men often join for one training only, with no desire to carry out the terms of their three years' enlistment unless it be convenient. Officers commanding companies are in fault for this; they are responsible for their companies under the existing law;² they should not enrol men unless they know them well, their employment, their place of residence, and whether they are likely to fulfil the provisions of the Act. They are too lenient with their men, and to save themselves trouble or perhaps unpopularity, or even politics may here again interpose, they enrol new hands rather than proceed by law against the old ones to compel them, under the penalties of the Militia Act, to fulfil their terms of enrolment. All this requires looking into and a thorough reformation. Rural corps have the disadvantage of such long distances between their companies that the Lieutenant-Colonel, who has of course his daily business to attend to, can hardly supervise their details; and it may happen that the Staff Officers who make the muster and the half-yearly inspections do not always, as a rule, take minute notice of what has on the surface an appearance of being 'all correct.'

"Rural companies should be always drilled at battalion head-quarters.

¹ Colonel Gzowski, by his energetic and liberal presidency of the Dominion Rifle Association, has contributed much to the shooting efficiency of the infantry of the Dominion.

² The law gives a loop-hole in allowing any man to claim discharge after six months' notice. He can, and sometimes does, give notice immediately after his first training, and cannot in that case be made to attend another.

"In the same degree that rural company drill works badly that of city corps does well, because men can assemble in long winter evenings in the drill-sheds without loss of pay, and they look upon their drill and lectures as a recreation. I have every year opposed the system of rural company drill: it has the effect of circulating some money through the locality, and they may be convenient and satisfy local interests; it also brings a body of men together, armed and equipped for a time. But in my opinion it wastes more arms and equipments and clothing than any good that can result from it, and I shall disband every independent company not affiliated to a battalion, except in Manitoba and British Columbia; and I should suggest, if possible, in future to abstain from annual drill at company head-quarters, unless the Captain holds a first-class certificate for drill and rifle instruction.

"This leads me to revert to the subject I have so often before dwelt upon—the necessity for some regimental permanent staff. The militia of Great Britain has, according to regimental strength, two Officers and from 30 to 36 staff sergeants, who are thorough drill instructors; the Quartermaster being charged with the care of arms and clothing, which are thus kept in order, and no loss from neglect or theft permitted. In fact, it is a delusion to believe that an efficient military force can exist in perfection without a trained permanent staff, an unprofitable expenditure of public money being often the consequence of dispensing with it."

Cavalry.

I venture to doubt whether Canada could supply so large or efficient a body of cavalry as has been by some imagined, who ignore the fact that Canadians are not a nation of horsemen. Toronto, Ottawa, Montreal, and Quebec are the only places where foxhounds are followed. The long, hard winter necessitates driving in a well-furred sleigh rather than riding, and in summer fast-trotting sulkies are more prevalent than hacks. Nevertheless the yeoman cavalry of Ontario and along the United States frontiers of Quebec and New Brunswick have before now done good service as outposts: the eyes, ears, feelers and veil of an army.

They have able and enthusiastic cavalry leaders in such men as Colonel Dennison, of Essay celebrity, Colonels Forsyth, Turnbull, Lovelace, Saunders, and others.

The country troops are of course rough in appearance compared to those of cities, who have more opportunities for dismounted drills, while their saddlery and appointments are kept in better order. The rural troops from their knowledge of the country are of course better scouts.

Artillery.

The artillery is perhaps the arm in which the natural military proclivities of Canadians appear at their best. Their efficiency compared with the short period of training has been a constant source of sur-

prise to me. The practical mobility of the field artillery of small country towns is due to its popularity among the sons of yeomen farmers who enrol their own pair of horses and enlist as drivers. Their first appearance would perhaps be painful to the hypercritical glance of a Royal Artilleryman, but familiarity would teach him that, give them time, and they will get their guns almost anywhere for you; their Officers would select good positions, and the fire, judging by their target practice, would be very fairly effective. The cities naturally produce the most intelligent gunners, as the rural districts do the best drivers. The system of selecting artillery marksmen fostered by the Dominion Artillery Association, and introduced into the Canadian Militia before it existed in England, has, I think, produced very good results. I trust I may be excused for quoting my own report which gives a *résumé* of the subject:—

Extracts from Report of the Dominion Inspector of Artillery.

“Field Artillery Generally.

“Considering the small cost to the Government, and the consequent short period allowed for training—16 days—I consider the Canadian Militia Field Artillery in a remarkable state of efficiency. I trust the number of horses will be increased to six per gun, with three spare in case of accidents, making a total of 45 horses per battery. The issue of black leather gaiters up to the knee and strapped spurs to mounted non-commissioned officers and men, though apparently a trifling matter, would tend much to efficiency; the trousers, often without straps, wrinkle up towards the knees, unsightly in appearance; they would gall the leg of a man riding any distance. The deficient and irregular supply of whips and spurs renders good driving impossible, and has been a source of accident as at Hamilton, Ont., when a gun team going up a steep incline could not be kept up to the collar, and were precipitated down a declivity, in this instance, fortunately without loss of life.

“Instead of the importation of the cumbrous ammunition wagons, I would recommend the adoption of a system of an enlarged limber supply as more handy, with fewer horses and less difficulty in driving, &c., as proposed by Major Ellis, R.A.

“The Dominion Artillery Association has, I think, by producing a spirit of emulation, been largely conducive to the present efficiency of the field artillery, while the system of efficiency badges for unpaid drills has been largely conducive of good results, especially to the artillery in cities and towns. A complete Field Battery of Instruction at each of the gunnery schools is absolutely necessary before instruction in field movements can be given.”

In spite of the very able essay of Major Holmes, Adjutant of the Kingston Gunnery School, I would not recommend a large increase to the Militia field artillery, but would prefer to see what is at present organized given double the period of drill—32 days instead of 16—and a proper equipment of ammunition wagons or limbers issued.

The greatly increased range and efficiency of infantry fire does not, in my opinion, point to the advisability of increasing our proportion of guns to infantry as formerly laid down in Europe. The close character of the country and the badness of roads in Canada would not, in my opinion, justify any large increase of field artillery. Better to render thoroughly efficient what we have got. Indifferent artillery or even good artillery badly handled is only an incumbrance.

It might be thought advisable to equip a few batteries with mitrailleurs, firing the same ammunition as the infantry, to act with cavalry and enable them to seize and hold an important point; but until some manufactory for small-arm ammunition is established in Canada, it would be rash to start an armament that would call for a larger reserve of what we have to import a distance of 4,000 miles, viz., small-arm ammunition.

With regard to the garrison artillery, I must again quote my own report and that of my Assistant-Inspector, Lieutenant-Colonel Price Lewes:—

“Garrison Artillery Generally.

“With the exception of the Montreal and St. John, N.B., Brigades of Garrison Artillery, I have found the garrison artillery in a very inefficient condition, mainly, I believe, for want of a weapon on the efficacy of which they can rely, as they cannot on the old smooth-bores that cumber our works and drill sheds. The introduction of Sir William Palliser’s comparatively inexpensive system of converting our old cannon into rifles in Canadian workshops, at a cost of 120*l.* each, the cost of the imported Palliser gun being 160*l.* exclusive of freight, is, in my opinion, the only tangible and permanent means of giving efficiency to this important branch of the service, especially in cities where both the industry, the guns, and the gunners, are most needed; and where intelligent mechanics may be found to form enthusiastic artillerymen to man the guns they forge in the defence of the city where they live. Judging by what has taken place in Great Britain, these results are not necessarily visionary for Canada. Having commanded the Gunnery School for Reserve Artillery at Woolwich, from its inception until I left for Canada, it was my duty to recommend the adoption of the Palliser 64-pounder for the Reserve Artillery of Great Britain. The immediate interest roused by this substitution (for ‘the old ‘gas-pipe guns,’ as the obsolete weapons were somewhat irreverently styled by the men who were supposed to fight them) raised the efficiency of the force in a manner incredible to one who did not witness it. The home Reserve Artillery of Great Britain musters 60,000 fairly trained gunners in addition to the regular reserves of the Royal Artillery. I would earnestly plead for the extension of the system to this part of the Empire.”

Lieutenant-Colonel Price Lewes reports:—

“I regret to find in the Halifax drill shed no stores for shifting ordnance exercises; in fact no appliances wherewith to instruct or interest the artilleryman in his work beyond a few 32-pounder

"smooth-bore guns mounted on traversing platforms. The Brigades of Halifax Artillery contain the material for as fine a force of garrison artillery as could be desired; but if the most ordinary appliances for instruction (which in England are possessed by the smallest volunteer artillery corps) are not given them a high state of efficiency cannot be expected. I trust this deficiency may be remedied, especially as regards Halifax and St. John, N.B., at both of which places are excellent drill sheds, and I feel confident that the results in increased efficiency will amply justify the trifling outlay required for the few stores referred to. These brigades have not carried out their annual gun practice, owing to the ammunition having only very recently been received, and I should recommend that, as the winter season has set in, the ammunition be retained until the spring, and then used for competitive practice."

In my own report I find the following:—

"Engineers."

"This branch of the Militia is sadly in want of materials, and means of instruction. They are without entrenching tools and the common appliances of their arm. Lieutenant-Colonel Scoble at Toronto, Major Kennedy at Montreal, and Captain Perley at St. John, N.B., are able and zealous Officers, anxious to produce efficiency, if the means were available.

"The two engineer companies at Montreal might with advantage be placed under the senior Officer of the arm at Montreal.

"I was not notified by any of the Deputy Adjutants-General of the districts of the proposed dates of inspection of engineer corps, and have therefore had no opportunity of judging accurately, but from want of the appliances before mentioned, and from previous inspections of some of the companies, I believe them to be little more than efficient infantry. The Toronto Engineers, Lieutenant-Colonel Scoble, have to a certain extent, I am informed, supplied material at their own expense."

They are very zealous and deserve great commendation and some assistance from Government, but I am not of opinion that, considering the very small sum of money voted for the Militia, it would be advisable to horse and establish so costly an institution as a pontoon train. Especially do I not think the game worth the candle in Canada, on the banks of whose forest rivers and streams for the most part are found the means of crossing, which a gang of lumber-men would very soon knock into a bridge or raft, with extra flotation if required from empty pork, flour, petroleum, or whisky barrels, which must be found where men congregate, or at all events in the stores of an army. There is no organization for the transport and supply of ammunition in the field, a question of vital importance in these days of breech-loaders.

Wednesday, May 7, 1879.

LIEUTENANT-GENERAL SIR JOHN H. LEFROY, K.C.M.G., C.B., R.A.,
&c., &c., in the Chair.

*Part III.—PERMANENTLY EMBODIED TROOPS AND MILITARY EDUCATIONAL
ESTABLISHMENTS OF CANADA.*

When the Imperial legions were withdrawn from Quebec, the last and most important stronghold of Canada proper, to me was confided the honour of forming a garrison of loyal Canadians to guard the Imperial flag that still floated over the ancient fortress.¹ A similar task devolved upon Captain G. T. French, R.A., with respect to Kingston.² How we have performed those duties is I believe being recognised by conferring on the Officers and soldiers we have trained during seven laborious years the honourable title of "Royal Canadian Artillery." What that labour was, can best be judged by any professional soldier picturing to himself the task of raising and training an artillery garrison and re-arming a fortress without professional assistants,³ as well as forming and conducting a theoretical and practical school of all arms, as may be understood on reference to the curriculum of subjects taught. The scholastic monotony has been varied by the necessity for using my pupils to suppress civil disturbances, but *vires acquirit eundo*. To the assistance given by Master Gunner Donaldson, R.A., and the sergeant gunnery instructors, I am indebted, but the credit is mainly due to the good material I had to work upon, *i.e.*, the gentlemen selected as Offi-

¹ It was a curious coincidence that the two regiments first to enter Quebec after its capitulation were the last to leave it more than a century after. To an Officer and detachment of the Royal Artillery, escorted by the 60th Royal American Rifles, was given the honour of hoisting the British flag at the conquest. On the withdrawal of the Imperial garrison from Quebec, to an Officer of the Royal Artillery, was handed over, by a detachment of the Royal Artillery and 60th Rifles, the flag, which I have no doubt my Canadian military children would honourably defend, if need be.

² Lieutenant-Colonel French subsequently organized the N. W. Mounted Police, and was succeeded at Kingston by Lieutenant Irwin, R.A., now Lieutenant-Colonel in the Canadian Militia.

³ The Royal Artillery Sergeant Assistant Gunnery Instructors were not sent out until the following spring. Meanwhile the fortress had been re-armed during a Canadian winter by recruits of three months. The Washington Treaty had not been signed, but faith in its provisions seemed perfect. The guns had been dismantled to enable the Royal Engineers to repair the platforms, and the troops had been withdrawn before there was time to remount them, but my task was comparatively lightened by the fact that all the artillery stores were left to my hand in the most perfect order by Captain Murray, R.A., under the directions of Colonel Gibbon, commanding Royal Artillery in British North America.

cers, viz., Lieutenant-Colonel Montizambert and those at Quebec, whose zeal, ability, and natural soldierly qualities rendered pleasant a task at times depressing from want of encouragement in quarters where I have perhaps unreasonably looked for it. I have no doubt that Lieutenant-Colonel French, my late colleague, as well as Lieutenant-Colonel Irwin, would endorse these remarks as far as concerns Lieutenant-Colonel Cotton and the Officers of the sister Gunnery School.

A reference to the Militia General Orders, dated 20th October, 1871, will best explain the original and dominant idea in the formation of the schools, namely, to carry out garrison duties by means of recruits from the Militia, and at the same time to utilize this garrison as a gunnery school. It soon became evident that at least one battery of trained soldiers was necessary for garrison duties, with a Staff to instruct recruits from the Militia who should be supernumerary to the regular garrison, while of course eight horses were not supposed by any soldier to be sufficient for "instruction in riding and driving, "moving field and siege guns, and general purposes." I have no doubt the originators of the plan fondly hoped, as I did, that it would be developed; but not a single gunner or horse has been added to the strength of the establishment during the seven years of its existence.

I obtained from Government the privilege of forage for the private horses of the Staff and of Officers attending the schools, and by so doing, have succeeded in horsing a couple of guns and in creating a riding establishment. If one may not point to success, it is at least permissible to tell one's mistakes. Mine was hopeful credulity in believing in the reasonable expansion of the Gunnery Schools to efficiency; and consequent rashness in undertaking the direction and command of a garrison, a Gunnery School, and what is practically a Staff College for all arms, with the inadequate details laid down in the General Order. The last annual report of the Gunnery Schools may show some part of the result of seven years' labour; and the report of Colonel Hewitt, R.E., the indefatigable Commandant of the Military College at Kingston, will show the success of his struggle to carry out military instruction with a hitherto inadequate Staff.¹

The commercial depression of the past few years has been no doubt in a great measure the cause of delayed development of military educational establishments in Canada.

Part IV.—ARMAMENT AND SUPPLY.

Small Arms and Ammunition.

The infantry are armed with the Snider rifle, an excellent and serviceable weapon, better suited to our Canadian Militia than the

¹ Those who wish to acquaint themselves thoroughly with this subject, should read the various reports by Colonel Strange and others, published by the Canadian Government.—ED.

Martini-Henry, of which it is to be regretted that the purchase has been commenced by Canada, as the General Commanding is of opinion "that we cannot afford to purchase the quantity in bulk, and to have "volunteers armed with two sorts of rifles and two descriptions of "cartridges on a line from the Atlantic to the Pacific, would be to "court disaster if they were called upon to take the field."

There are only 70,000 Snider rifles in Canada, which, when we deduct 40,000 in the hands of the Active Militia, leaves only 30,000 for our Reserve Militia, which numbers 600,000 men, a portion of whom at least would have to be called out and trained in emergency. The amount of ammunition in the country is only 150 rounds per rifle, an amount which I fear the Canadian Militia might possibly fire away in one or two general actions.

The General Commanding points out the necessity for a further provision:—

"I cannot, with a prudent outlook to the possibility of cartridges "being suddenly required for service, recommend the diminution of "our supply, which, on the contrary, should never be less than 300 "rounds per rifle. Cartridges have to be imported from England, as "I regret to say we have no manufactories in this country to produce "them, and as Snider cartridges will by and by not be forthcoming in "the Royal Arsenal, it may be necessary for us to bespeak them some "time before we can demand our annual supply."

Indeed the manufacture of small arm ammunition appears to me a manifest necessity, as also that for artillery. To depend on a base 4,000 miles across the Atlantic in the event of emergency would be most hazardous; besides such a system would necessitate keeping a large stock on hand, which, with so perishable an article as ammunition, would be unadvisable, to say nothing of the constant changes in war material. The Militia of Canada without an arsenal to rely on, not only for ammunition, but for the manufacture and repair of gun-carriages, harness, camp equipage, without transport, commissariat, or ambulances, &c., would not be in an enviable position. The subject has been well treated in the Dominion Artillery Association Prize Essays for 1878, by Colonel Montizambert and Captain Prevost, of the Canadian Artillery.

The essay of the former has been printed in the Proceedings of this Institution, and those wishing for details cannot do better than refer to it (Vol. XXII, No. XCIV). I shall not therefore enlarge on the subject, but simply remark that Halifax, Quebec, Kingston, and Ottawa are suitable localities for the establishment of arsenals and dépôts for supply. The first three are fortified, and contain suitable government buildings and lands, while the latter is far removed from the frontier. Both Toronto and Montreal, though centres of industry, are exposed, and have been captured in previous invasions by the Americans. The rate of labour is quite as cheap and probably more reliable as regards strikes than it appears to be in England, while the raw materials, iron, wood, leather, &c., are abundant, and of the best quality. Coals are not, of course, as cheap as in great English manufacturing centres, but the water power is unrivalled, and wood fuel

(which is so abundant), when used as charcoal in the production of the finest ironwork, produces the most reliable kinds, free from the sulphur and phosphorus which it is so difficult to eliminate from coal-worked iron. That produced at the Londonderry Steel Company of Canada, as reported on by Messrs. Gilbert and Son, Montreal, "is said to have a tensile strength of 65,000 lbs. per square inch, "being more than 23 per cent. greater than that of the Ridsdale iron "used for gun tubes in Britain. . . . This iron in working "also showed remarkable properties of welding." This subject of manufacture of war materials in Canada is of the greatest importance to the Empire, as rendering us self-reliant at a time when such self-reliance would be essential to the successful resistance of attack.

That most vital question, an organized system for the supply of infantry ammunition in the field, does not seem to have been considered.

Artillery Armament.

It is not necessary for me to describe the magnificent armament of the Halifax forts, nor to detail the armament of some 400 smooth-bore guns, scattered over the Dominion, but of little use in modern war, except against boat attack. I can best, perhaps, render service by pointing out the importance of converting this obsolete armament into serviceable rifled guns, in accordance with the requirements of modern war. The task is neither so difficult nor expensive as may be imagined.

In addition to the rifled guns already detailed as mounted, in Vancouver Island, and the harbour of St. John's, New Brunswick, there are at Quebec, eight 7-inch Armstrong breech-loading rifled guns. They have hitherto been considered very weak guns, but by the use of an improved gas check, and by the conversion of the gun into a side breech-loader by turning the trunnions, as has been done lately at Woolwich, the gun may be made to take a large charge of the mild pebble powder, which will increase the power of the gun while it diminishes the initial strain on the breech. There are also two of the same 7-inch B.L.R. at Kingston. It was found that in extreme frost, the breech-closing apparatus was difficult to open, but by resorting to a very simple expedient, I have overcome this difficulty, and the guns might be considered fairly efficient, especially from their dominant position at Quebec, where they command the comparatively unarmoured deck of an ironclad, which in approaching end-on, would present a most favourable parallelogram to artillery fire.

In addition to the Armstrong breech-loaders are ten 32-64-pounder Palliser, and two powerful guns presented by Sir William Palliser, an 8-inch and a 7-inch, converted on his principle. I find from an old newspaper extract, that "these guns cost Sir William 700*l.* sterling. "He had to buy them from Her Majesty's Government, and pay "Sir W. Armstrong for their conversion. The freight came to "60*l.* 10*s.* 6*d.* He has already ordered a third gun, given by the

"Dominion Government for conversion at Montreal, for which Sir William pays the cost, and a fourth 10-inch gun (which will probably cost more than the three others put together) he has ordered to be made in England, as a gift to the Dominion Government. He further offers to convert all her old guns without profit, commission, or royalty, to which he has a legal right by his patent. Why this liberality? Why this affection for old Quebec? Must we believe *noblesse oblige*? There are patents of nobility more noble than inherited titles, but Sir William has a claim to both. . . ."

(It was during the period that war was imminent with Russia), and the *Quebec Chronicle* goes on to remark: "The gift of Sir William Palliser is indeed a timely one; unlike anything in this age, it reads like a bit of old Elizabethan story, when English gentlemen from Devon fitted out warships 'at their own charges' to meet the great Spanish Armada."

My first report, after landing in Canada seven years ago, was to recommend the conversion of our useless old smooth-bores into rifled guns, on the Palliser principle, utilizing thereby the old carriages, sidearms, and general stores, and even the projectiles, the calibre remaining the same. Such an armament would be pre-eminently suitable to Canada, the defence of which will mainly depend on Canadian Plevnas. I have therefore continued to reiterate the suggestion in which I have been supported by the Major-General Commanding since his arrival in Canada. In dwelling upon the economy of converting old smooth-bore guns into new rifles, I do not forget the fact that we require a few powerful first-class armour-plate piercing guns at St. John, New Brunswick, Quebec, and Vancouver's Island. Except at Halifax, where there is an Imperial garrison, we have not one such gun in the Dominion of Canada. My last report is as follows:—

"But as regards future armament, I would again solicit attention to the advisability of adopting the Palliser system for converting in this country the 400 old smooth-bore guns into rifles, as already recommended by the General Officer in command, page xix of last year's report, since which the remarkable power developed by the chambered 7-inch Palliser gun converted in England render it a suitable armour-plate piercing gun for coast defences, though for land fronts and entrenched positions along our extended frontier, I feel certain no better or cheaper plan could be adopted than the gradual conversion of our smooth-bores into 90-pounder, 64-pounder, and 40-pounder rifles at the trifling cost of about 120*l.* per gun, while the old wood and iron carriages, platforms, &c., could be utilized, and new wooden carriages have been made in this country at a less cost than that of importation.

"The relative cost of constructing wooden carriages and traversing platforms at Quebec and importing iron or wooden ones is shown in the following estimate:—

*"Comparative Cost of Home Manufacture and Importation of Garrison
"Gun Carriages.*

	Imported from England.	Home Manufacture.
	\$ cts.	\$ cts.
It will be seen from the Woolwich Vocabulary of Stores that a wrought-iron double plate sliding carriage and platform will cost, with freight, &c., added, in round numbers, about	1,700 00	
The same of wood.....	639 00	
do. made in Quebec, as proposed.....	550 00
Wrought-iron carriage for 64-32 pounders about.....	375 00	
Wood carriage built in Quebec.....	170 00
do. for 64-32-pounders, imported, about ...	190 00	

"The manufacture of such material would not only be a saving of expenditure, but would be a benefit to the country by employing our own artificers and expending the money in the Dominion."

It must be borne in mind that the Dominion Parliament will much more readily vote money to be expended *in the country* than send out of it for the purchase of war material.

"I beg to recommend strongly the report of Messrs. Gilbert and Co., Canada Engine Works, to favourable consideration; trusting that if I can report satisfactorily on the proof of the gun now nearly completed at Montreal the Government will not hesitate to order the gradual conversion of the 400 smooth-bore guns now comparatively useless on our fortifications, and that a sum of money will be placed on the estimates to meet this expenditure as well as that for seventeen 7-inch Palliser rifles in lieu of seventeen 64-32-pounders previously ordered from Woolwich by the Dominion Government.

"The differences of cost between the home manufacture and importation speak for themselves. The efficiency of Canadian manufacture will, I believe, be established by the proof of the gun now being constructed, as well as inferentially from the fact of the success in the United States of the Palliser principle of conversion and construction. I would, however, for the future manufacture in conversion of 64-32-pounders recommend that the A-tube be prolonged about 2 feet 6 inches beyond the muzzle of the cast-iron gun, which would allow of sufficient length for the use of pebble powder, which, being slower burning and exercising less strain on the gun, yet gives a higher initial velocity than the *poudre brutale* for which the short Woolwich guns were originally constructed. With the addition of the chamber I believe the 64-32-pounders could be made to penetrate considerably more than 5 inches of iron, as it has already done. The cost of this change would be inappreciable, and the practical inconvenience of increased length *nil*, as the preponderance already existing would allow of an increase of 4 feet

"of A-tube if required for ballistic purposes. I believe it would also
"be advisable in lieu of studs to adopt the expanding base-ring
"system so successfully experimented upon at Shoeburyness, and
"already introduced in the United States as invented by Captain
"Butler, U.S.A. It will be seen that a system of *gradual conversion*
"will enable us (at a minimum of cost and maximum of efficiency) to
"avail ourselves of the scientific experiments carried on at Shoebury-
"ness and elsewhere."

When it is remembered that science has to wait upon her handmaid, mechanical skill, the comparatively circuitous yet progressive march of modern artillery is not surprising. The earliest guns were of great length to allow of the consumption of the weak slow-burning powder. They were composite breech-loaders of coiled wrought iron. When the powder was improved, the breech-closing apparatus in the infancy of mechanical skill could not be made strong enough, and had to be abandoned for muzzle-loading, the cumbersome length was got rid of. Then the powder, being so improved as to acquire the title of *poudre brutale*, had to be modified so as to reduce the strain of enormous charges on monster guns, which will again have to be lengthened and chambered and probably breech-loaded. It is not within the scope of this paper to discuss the claims of various systems, and certainly not hastily to condemn our own, which (in spite of the impetuous attacks made upon it since the accidental burst of a single gun) has stood the test of time, and will no doubt be further modified to suit modern requirements. Under the circumstances, however, I must respectfully admit that I do not regret that the advice, I presume given by the Colonial Defence Committee, to purchase short Woolwich guns, has not been followed by the Dominion of Canada.

Meantime the batteries of garrison artillery organized at the important points marked on the map should be employed in constructing batteries reveted with the iron-band gabions so easily constructed from the hooping of bales of goods. Such revetments would last half a century with but few repairs, and if armed with 64-32 Palliser converted guns to prevent close attack, and cover torpedoes, would render secure the harbours of our long lake frontier, as well as other important points, which the economic application of the Moncrieff principle would render very formidable. The requirements of a country like Canada and the peculiar aptitudes of its people require that European military organizations should be modified to suit them.

The Militia garrison artillery and engineer corps should be amalgamated to form an universal pioneer corps to work guns of position or garrison, as well as to construct and arm the batteries they fight, which would most probably be raised in conjunction with torpedo systems. The other rough pioneer work of bridging, &c., would come most naturally to the intelligent Canadian mechanics who chiefly compose the corps of garrison artillery and engineers. The latter corps are very few in number, and in isolated positions.

In conclusion, it must be borne in mind that Canada never has been and never can be dependent on British bayonets. The history of her struggles against invasion showed that she could and did, with

the assistance of but few British troops, bear the brunt of it with her militia, who almost unaided rolled back the tide of war from her shores. Before the conclusion of the Treaty of Peace in 1814-15, not a single American sentry or post remained on Canadian shore, while we were in possession of Fort Mackinac and other points in what is now the State of Michigan.

Part V.—CANADIAN CONTINGENT FOR IMPERIAL SERVICE AND MILITARY COLONIZATION.

"When danger of war, real or imaginary, threatens the Empire, the first thought is what a broad mark the circle of British Colonies offers to an enemy: the second, by what a mighty circle of fortresses and outworks the centre of British power is defended. The second thought is the sounder. Merely to extend territorial possessions is to give so many more hostages to fortune in war. The more the British Empire is of this character the weaker its line of defence. But expansions of territorial dominion which have widened the limits within which the Anglo-Saxon race can spread and multiply, add to the vitality of the Empire. The British Empire is self-sufficient if its resources can be brought into juxtaposition so as to supplement each other."¹

The offer of a Canadian contingent suggested very forcibly the capabilities England possesses for military purposes in its Colonies, and what very little use has hitherto been made of them.

"Were it possible to imagine Germany, Austria, or Russia possessed of Colonial dominion like ours, we may be sure the first thought to occur to the rulers of any of these Empires would be the contingent each dependency could be made to contribute to the army." But though England has neither the power nor the desire to enact a military contribution of men from the colonies, yet what could not be demanded was volunteered!

"The staunch and remarkable loyalty of Canada to the British Crown has not perhaps ever been more significantly manifested than during the early part of the past and previous year, when offers of service in the event of war were preferred to the extent of raising in Canada several thousand men to serve with the British Army. These offers, some of personal service, others to raise battalions, bore the stamp of a thorough determination to give willing and material reinforcement to Her Majesty's troops. They were the spontaneous expressions of a loyal and a high-spirited people to throw in their lot, as a very important factor, in the destinies of Great Britain. These offers were as cordially received by the Imperial Government as they were loyally made, and should the occasion have arisen, no doubt but that the hardy and stalwart sons of Canada would have been

¹ From a leading article in the *Times*, March 8th, 1879.

"found standing manfully shoulder to shoulder with their native-born brethren of that 'old country' which they love so well."

Let us hope that in quieter times the generous offer will not be forgotten on either side.

A peace military system that does not admit of ready expansion to meet the emergency of war without dislocation is not worth the money spent on it.

Of the 12 military districts into which Canada is divided, 11 and 12 (Manitoba and British Columbia) are still comparatively unpeopled territories, and need not be considered in the present plan. It was proposed that the Canadian war contingent, 10,000 strong, should number two brigades of 5,000 strong, a brigade of three field batteries, an artillery pioneer corps, combining the duties of siege or position artillery with those of pioneers artificers, and a regiment of cavalry.

The nucleus and recruiting dépôt of this force in peace time to consist of two small battalions of 500 men each, each company 100 strong named, numbered after, and recruited for and affiliated with the headquarters of each of the 10 military districts. Commanding Officers of Militia Corps forwarding to the Deputy Adjutant-General of each military district the names of Officers and men wishing to serve in the contingent, Officers of the School of Gunnery, and Military College Cadets being given a preference. The Militia Medical Officer of the district staff could examine recruits to prevent ineligible men being forwarded to battalion head-quarters. The two dépôt battalions could be further divided into wings if necessary, and quartered at St. John, New Brunswick, and Quebec, with detachment on St. Helen's, Montreal, and Fort Isle-aux-Nois.

The other battalion divided between Kingston and Toronto, with a company doing duty as a guard for the Governor-General, furnishing orderlies at head-quarters, &c. There is barrack accommodation at all the above places except head-quarters, and the barracks at St. Helen's and St. John's, both burnt, would have to be rebuilt.

The artillery organization would only require the present gunnery schools at Kingston and Quebec, to have the horses increased to a complete field battery for each, and an artillery artificer or engineer company added for the repair of fortifications, war material, &c.

The cavalry might be represented by a troop at Toronto, and one at Quebec, there being a riding school at both places.

The above would amply provide for garrison duties, maintaining internal order, and the instruction of the Militia, while there could be expanded into an Army Division for war service on their own frontiers, in Europe or Asia, or such proportions of them, one, two or three battalions as might be wished for, such service battalions being paid by Great Britain when serving out of Canada; the dépôt battalions always to remain and recruit in Canada, invalids and time-expired men being returned to their original companies for discharge.

I believe the above is the only feasible organization for an Imperial contingent. The offers of service made by certain Militia corps en

¹ General Sir Selby Smyth's Report.

bloc, though well meant, were quite incapable of fulfilment without dislocating the agriculture and commerce of the country as well as its home defence.

It is to be hoped the mistake made in raising the 100th Canadians will never again be repeated. They are probably a serviceable corps, but having no recruiting depôt in Canada they have long ceased to have anything Canadian about them beyond the maple leaf badge they have carried to serve in our Indian Empire. There seems to be a madness among a certain class for ignoring the sentiment of soldiers. Discipline and *esprit* suffer when soldiers are made to bear a badge and title to which their hearts do not respond.

There would be a difficulty about the rates of pay for an Imperial contingent. The present Canadian rates of pay of Officers are higher than those of the British Army, and however willing, there are not a numerous class in Canada who would be able to serve the Empire even partially at their own expense.

Military Colonization in Canada.

In considering the question of a Canadian contingent for Imperial service, it would be manifestly unjust and impolitic to allow many of the young men of a young country to be absorbed by military service in Europe, without making provision for their final return and settlement in Canada. To the young men themselves and their relatives it would be equally cruel and unjust to pay them off in London or elsewhere, at the conclusion of their service, with a few pounds in their pockets, perhaps to become waifs and strays of the great floating demoralized population of some great city. Undoubtedly emigration is one of the great questions of the day, which will not be answered by "drift;" 40,000,000 on a comparatively small island, with inadequate food supply, and failing manufactures, on the other side of a ten days' sail, 4,000,000 scattered along a riband of 4,000 miles, *i.e.*, the population of one city, London, occupying or rather struggling with the cultivation and development of a territory as large as Europe, with an arable area equal to that of Europe without Russia.

Manufacturing magnates may for manifest reasons discourage emigration, neglect our colonies, keep home population at starvation point, until they have been met by strikes that paralyse industry, and threaten to transfer our trade to foreign countries. Then instead of the people being encouraged to emigrate, they are taught to clamour for those agrarian laws that will sooner or later shake Great Britain, as they shook Rome, to her very foundation, unless the emigration question is systematically considered and encouraged. We have been willing to struggle for black empire as long as it required cotton clothing, but as soon as it threatens to cover its nakedness without Manchester help, we say perish India! or Africa, or anywhere else that won't clothe itself with our cotton, and yet we ignore the manifest means of protecting ourselves by a commercial Zollverein with our colonies. Surely British merchants don't need to be taught by British soldiers that commerce means empire, and *vice versâ*. The German Empire was

consolidated by commerce, not cannon. The treaty of the Zollverein, in 1851, paved the way for that reunion of the German Principalities consummated at Sedan, yet we seem indifferent to the commercial development of an Anglo-Saxon Empire and its commercial relations with ourselves, which are surely capable of adjustment to the mutual advantage of ourselves and our colonies. Canada has already led the way by proposing differential duties against the United States, manifestly in favour of Great Britain, whose press, misunderstanding the points at issue, has met her with expressed displeasure, instead of encouragement.

True there is room for uneasiness as to how far the trade self-protection of Australia and Canada, as opposed to protection of the general Imperial interests, may be carried, but the game is yet in our own hands. Commercial union with our colonies is surely possible, unless we decline to discuss the matter with them, and prefer the system of "drift." Let us remember that though we drifted into empire in the east, we drifted out of it in the west, when a question of tariffs in 1776 lost us the American colonies, and a hundred years later those colonies were still suffering from the internecine strife that again rose out of a question of tariffs, though the slavery question was the stalking horse selected.

India can never be the home of the Anglo-Saxon yeoman. It is a magnificent field for the cultivation of military and administrative talent among intellectually selected specimens of our upper classes. The birthright of the British yeoman, the broad lands of our colonies, were of necessity ceded with responsible government to the Colonial Legislatures. The Crown lands no longer belong to the Crown of Great Britain, and this is the main impediment to any extensive system of organized military emigration. Yet as it is manifestly to the advantage of the colonies that there should be an organized system of emigration, instead of leaving them to the unhappy-go-unlucky want of system by which stowaways and criminals, effeminate clerks, and gentlemen whose heads are sometimes as soft as their hands, may drift to their shores.

Hitherto the military emigration of British Officers and soldiers has failed because it was based on wrong principles, and that lately attempted by Canada herself in giving grants of land to the time-expired soldiers of the battalions sent for service to Fort Garry has benefited nobody but land speculators, because it was based upon broad republican principles, which do not suit soldiers or men habituated to discipline. An indiscriminate grant of land order for 160 acres was given to Officers and men alike. The grant had a name, but no local habitation; its whereabouts was not defined; to the mind of the supposed settler it might turn out a shaking swamp (muskeg), a strip of alkaline desert, or an uncleared wilderness of valueless wood. No Officer of sense or self-respect would think of settling down on an equality with Private Tommy Atkins and Mrs. T., to whose husband he had so lately administered pack-drill. Unscrupulous Officers were tempted to buy the prospective claims of their men for the price of a few bottles of old rye whisky, not to become *bonâ fide* settlers, but to hold, and subse-

quently to sell, to land speculators. I am speaking with a knowledge of facts.

Again, the old colonization by Imperial troops was based on the idea that every soldier, after perhaps 21 years' hard service, mainly in tropical climates, was fit, in comparatively old age, to blossom into a successful colonial farmer, no matter what his antecedents—being without capital, energy, or agricultural experience. The first or second semi-Arctic winter of Canada drove him to despair and drink, to which military service in old times only too frequently predisposed a man. As for the Officers, not having been in the first instance granted estates commensurate with their rank, and having spent most of their capital or retired pay in the purchase of land, they sank to the level of the rank and file, and their sons, often without proper education, intermarried with the daughters of the ordinary working population, or in some cases of their fathers' servants, who eventually owned the farm on which they had been hired to work. Canada is strewn with the wrecks of the families of British Officers. Of course there are exceptions to every rule. One of the most striking is that of the descendants of the 79th Highlanders, Officers and men, disbanded after the war in 1760, settled at Murray Bay, near Quebec, 15 years afterwards. They left their farms to march against the Americans invading Canada, and returned to their ploughshares when they sheathed their victorious claymores.

The settlement of the 79th Highlanders was upon the old French feudal system. The Colonel and Officers were given seigniorial grants of land and magisterial privileges, and their descendants are still to be found loyal to the Crown, and curiously enough the seigniorial estates have devolved upon another Officer of the 79th, nearly a century after the original settlement, by right of his wife, the daughter of the last seigneur. The seigniorial privileges have been abolished.

The original settlers were not supplied with Scotch wives, and the amiable little French Canadian girls with whom they intermarried made them good Catholics and happy fathers of a numerous progeny, still retaining the typical frame and vigour of the Scot though speaking in the softer tongue of France.

Emigration to the old province of Quebec is no longer required. The French Canadians have increased so rapidly as to have already emigrated in considerable numbers to the United States. And the fertile province of Ontario has also got far beyond the need of military emigration, but it is required to open up what will be the great grain-producing valley of the Saskatchewan with its coal-fields—a fertile belt of alluvial prairie soil with an acreage about equal to that of Spain, France, and England put together. Here such pioneers would be wanted in the first instance to build the Pacific railroad, guard the depôts of supplies, &c., form settlements along the route, and give military security against Indians at a cost that could scarcely, by any possibility, reach what Canada already pays for her mounted military police, 1,000 dollars per man per annum. Far less would be the cost of the passage of military settlers and their families with a supply

of three years' rations and agricultural implements, while the covered carts that conveyed them to their location on their prairie home would give shelter until quarters were constructed. British Columbia, especially along its southern frontier and in Vancouver's Island, requires such military settlements for manifest reasons it is not necessary to discuss. The climate is more favourable to our race than that of any colony, except perhaps that of New Zealand and that of Tasmania; it resembles England without the east wind. The same physical causes that have contributed to England's greatness will, to a certain extent, create in Vancouver's Island, in no very remote future, a prosperous country. The equable temperature produced by the equatorial current, corresponding in the Pacific to the Atlantic Gulf Stream, brings down the isothermal lines far south of the corresponding latitudes on the eastern coast, creating a climate that gives a maximum of working days in the year as against climates of extremes. Vancouver's Island and British Columbia is as large as France and Ireland, but the arable area is contracted by the mountain ranges; there are, however, vast tracts of brush-grass suitable for herds that require no house wintering. The coal, iron, and gold, and splendid timber not far from a series of magnificent harbours, will make Vancouver a trade-starting point from America for Asia—as England has been from Europe to America. If there is any truth in Buckle's "History of Civilization," Western Britain will be great when, the Californian, receiving no fresh blood from Europe, has degenerated into the *sans souci* of the southern European.

This is the country that asks for secession for want of railway arterial connection with Canada. It is too far for our population to reach it by the ordinary system of "drift."

The short-service system of our Army will supply a young, vigorous, and intelligent class of emigrants, who have been long enough in the Army to learn habits of order and obedience without being so long as to acquire a dislike for hard labour, or the intemperate habits too often the result of monotonous and protracted service in a tropical climate. To lead your short-service Army reserves, and settle them where they are most wanted, on the exposed frontiers of the Empire, as the Roman legions were planted with their Officers to hold the line of the Danube, and become in long ages the Roumanian peoples, you soon will have by the Compulsory Retirement Warrant a plethora of young energetic Officers condemned prematurely to linger grumblingly on the steps of "the crutch and toothpick." You may find among them, though now "mute and inglorious," some Raleigh or Miles Standish, and (if less visionary and fanatic than Elizabethan or Puritan heroes) crowds of such self-reliant cavaliers as planted the Old Dominion that you lost through "drift." Let your young, though time-expired soldiers, go and build you up a new Dominion on the Pacific slopes. The lands which no longer belong to the Crown may be regained by the purchase of shares in the Canadian Pacific Railroad, in accordance with the original plan proposed by Sir John A. Macdonald, Premier of Canada, viz., to build the line by the sale of land of no value to Canada until settled, allotting a strip of territory along

the proposed Pacific Railroad route as a portion of the shares and security of those who advanced capital to build the line. Other railway schemes, notably the Grand Trunk, have been the ruin of many, because almost all the shares were in the hands of holders living in England. See that the Canadians take a fair share of this responsibility, which they are quite ready to do, seeing they have attempted to build the road alone without help beyond an Imperial guarantee to their loan of 3,000,000*l*. Railway stock may sink, an Egyptian Khedive may repudiate, but soil along a railway in a suitable climate cannot remain valueless, and is a material guarantee against loss. To enable the Imperial Government to carry out an organized scheme of military colonization, it will be necessary for her to purchase stock (which will carry with it land) in the Canadian Pacific Railway. It is a truer, safer route to India through her own territory than that she purchased by her shares in the Suez Canal. Canada should of course start a similar system by selecting military colonists from the Officers and men of her permanently embodied Militia and Contingent for Imperial service when the necessity for such arises. She will by this means not only develop her territory, and give it protection, but obtain efficient military service without running into the bottomless expenditure of Army pensions.¹

The success of any such system will depend entirely on selection pure and simple of qualified Officers, who must be let alone in their sub-selection. Any attempt at development of the "poor devil, give him a berth, system," can't possibly succeed, when men have to contend against nature, which must be fought with her own weapons, "selection of the fittest."

The selected three years' time-expired good conduct non-commissioned officer or soldier from the British Army or Canadian regular troops, should sign an agreement to serve five years, the first two in one of the Canadian depôts of regular troops, but be liable to dismissal for misconduct or laziness. He would learn the country, and the depôt Officers would learn his character and ability. At the expiration of the first two years of probation, he would be sent on to a military farm on the Pacific Railway or frontier of British Columbia, where he would be employed in constructing the railway and learning practical agriculture on the Government farms under Officers and non-commissioned officers who had learned the work by similar previous training. Should he still have conducted himself well, and shown that he would be likely to succeed on a farm, he would be given one in a series of villages. His house he would previously have assisted to build with his comrades while working as a military labourer; during his five years' period he would be receiving rations and pay; but after being started on a farm with a house, implements, and rations till the first harvest was reaped, he should require no more assistance, but be still liable to frontier military or police service, and military discipline under his chiefs. It would be necessary to continue pay to

¹ The British capitalist will serve himself and his country better by investing in such a railway and colonization scheme, than by lending his money to Russia for the construction of strategic railways.

Officers and non-commissioned officers supervising work and maintaining discipline for which it would be necessary to invest them with magisterial powers.

Captain J. C. R. COLOMB, R.M.A.: I wish to express what I feel sure is the feeling of everybody who has listened to this paper, viz., the gratitude which is due to Colonel Strange for coming forward here and giving us such valuable information, and which would involve vast personal labour had persons to seek for it themselves. It is only those who read these papers and study these subjects who are at all aware of the depth of research required to bring forward such a paper as that to which we have just had the pleasure of listening. With regard to the first point about the Pacific seaboard, Colonel Strange remarks with reference to Alaska that it is "a slice with which one eagle accommodated the other, perhaps with a "prospect of a future carcase in that locality." It may be useful to state that there is no "perhaps" about it. In the reports of the General and the American Commission that were sent to Alaska by the American Government previous to the arrangement being carried out, the object stated in that confidential report subsequently published (I believe accidentally), that the only value of Alaska was that it, in a military sense, would be a position which would muzzle British power in the North Pacific, and that with regard to trading interests it would and must bring about the cession of British Columbia to the States. So there is no "perhaps" about it. Colonel Strange remarks: "It is hardly to be supposed that the mistress "of the seas and the eldest daughter, Canada, who already ranks third among "the commercial navies of the world, would permit the siege train destined "for the attack on Quebec to be conveyed by sea." Well, looking to two facts I think it is not to be supposed that we even dream that such a thing may happen, but there is a great deal of difference between having an opinion and a wish and taking practical measures for carrying it out. When we talk in this way, that it is hard to suppose the mistress of the seas would not do this and would not do that, what I think behoves everybody to weigh and consider is, what preparation is she making? because whatever her wish is, her actual power to do what she wishes will depend upon the preparation she makes, and I do positively declare that we are, I think, in great danger of assuming too much with regard to that question. Let everybody who assumes that it would hardly be supposed the mistress of the seas would not do so and so, earnestly seek out what she is doing now, what preparation she is making, because although you may not wish it to be supposed, it may unfortunately happen in consequence of your own negligence. Things have happened that English people never supposed would happen.

With regard to the Pacific seaboard I wish to offer one or two very brief remarks. There is another value, which is the coal value, that Colonel Strange alluded to, and I think the English people generally are suffering from great ignorance and apathy with regard to all these things which lie outside the immediate locality in which they live. With regard to this very part of the seaboard, two years ago I read a paper here on our naval and military position in the North Pacific, and I gave some particulars of the coal mines at Vancouver's. There was a very interesting book published not many months ago by a well known member of Parliament, Mr. Hussey Vivian, on his trip to America, and in that book he entered largely into questions concerning Canada; but he makes a statement which is absolutely incorrect, and it is those statements that mislead people to a great extent. He says for instance, Nature has only provided Canada with two coal-fields, one in Nova Scotia and the other in New Brunswick; but the best coal-field as regards quality is on the Pacific seaboard of Canada, and this fact he appeared to be ignorant of. That gives another importance to the Pacific seaboard. Colonel Strange points to the arguments that have taken place as to whether the defence of British Columbia or our seaboard on the Pacific is an Imperial question, and until we really believe in this, that everything that is vital to our Empire is an Imperial question, we shall always be in a confusion about it. Now there is a very extraordinary result produced by the difference of opinion as to what is and what is not an Imperial question. Colonel

Strange has brought the question before us whether it is the Dominion of Canada or the Empire of Great Britain which should provide for the defence of that place, but if you lose that point, if you lose those coal mines, the parts of the Empire which will most directly suffer are Great Britain and Australia. If once you lose that point you release the whole Pacific seaboard of America; you cease to have the power of checking the cruisers such as were bought by Russia the other day, leaving her Pacific ports. Your fleets cannot keep the sea, and Australia is open, and the road to Australia is an Imperial question, therefore the security of this point is certainly an Imperial question. We call an Imperial question anything that concerns the British people living in the United Kingdom, and as long as that view continues, so long shall we have confusion as to what is Imperial and what is not. Take the Pacific Railway—nine men out of ten in this country will tell you that is a Canadian concern—she never will be able to make it. This is all nonsense, for the Pacific Railway is an Imperial question. How few people think it is an Imperial question. We must remember the construction of that line will bring Australia, China, and Japan nearer—as regards time—to us. Taking the sea as our own dominion, for it must be our dominion if we are to live, it gives us the shortest possible line through our dominion of the sea and through the British dominion in North America. Then you say that is a question of money, and we cannot agree about it, and so it drops. The trade of Australia is enormously increasing, and anybody who has read *Payne's European Colonies* will get a very interesting account there of the gradual shifting of civilization following sea basins. He traces the ancient colonies and he traces the shifting from the Mediterranean basin to the Atlantic. Now civilization and progress have already commenced to shift from the basin of the Atlantic to that of the Pacific. At this moment what has happened with regard to the Suez Canal is happening with regard to the railway across America. The effect of cutting the Suez Canal has been very much more in favour of countries having Mediterranean seaboard than it has been to us as a commercial matter, and nobody can watch what has been the effect on the commerce in the Pacific without observing that it is in like manner being diverted towards the States. The only possible way for us to get it in the future is by the Canadian Railway. The British people now have the opportunity of doing what our fathers for centuries were endeavouring to do, to find a short northern route to the other side of the world. Between 1800 and 1845 we spent more than a million upon Arctic Expeditions, all for what? to get a short route to the other side of the world. We have found it, there it is through British North America, and if completed by a railway it would cost some ten millions; so we despise what we have found and our fathers sought. We should, however, not only regard this railway from the standpoint of its strategical value to Canada, but as vitally concerning future British power in the Pacific and as the key to British power in the future to command the sea on the other side of the world.

Colonel FLETCHER, C.M.G.: I should not have risen to say anything except to supply a slight omission which Colonel Strange's own modesty has led him to make in the paper that he has just read. He alluded to the excellence of the Canadian Artillery without saying that that excellence is in great measure due to the exceeding energy, skill, and tact that he has shown in organizing, drilling, and getting ready for service the batteries of artillery now in that Dominion. Through the exertions of Colonel Strange, Colonel French, and others, schools of gunnery have been established, which form a sort of nucleus of a permanent force. I won't call it a permanent force, but a nucleus of a place of instruction and a type on which other bodies of troops can be formed. It so often happens that the services of Officers who are away from their corps are not remembered; therefore I did not like to lose the opportunity of making allusion from what I saw myself as Military Secretary in Canada to the excellent work done by the Officers of the Royal Artillery while attached to the Dominion Forces.

Sir HENRY LEEFROY: Perhaps I can bear rather more recent testimony even than my friend Colonel Fletcher, for I had the good fortune and pleasure of being the guest of Colonel Strange at Quebec less than two years ago, and of there seeing a field battery that might have appeared with credit on Woolwich Common, going through its drill, and of seeing the whole machinery of the School of Instruction

carried on, with all the greater intelligence and zeal that it was entirely voluntary. In that venerable garrison, which I knew 30 years ago in its palmy days, I saw the spirit of military life kept alive entirely through the energy of Colonel Strange, and I had the pleasure of being challenged by a sentry, which I certainly never expected to occur again in the citadel of Quebec. I cannot therefore overstate the obligation which not only we ourselves as representing Imperial interests in this great question, but the Dominion of Canada owes to Colonel Strange for his efforts to keep alive by what is personally a characteristic of the man himself, a spirit of soldiership and of zeal, which would otherwise have no representation there. I am one of those who think the best security we have for the peace of Canada is the multiplication of commercial ties, the exercise of a wise diplomacy, and the removal of sources of irritation. Ruin to Canada would be ruin to multitudes in all the Northern States. Great and prosperous towns now live upon the Canadian trade, therefore designs of a hostile nature against Canada, more serious than Fenian raids, are as far remote as anything in politics can be said to be. But there is another point of view. No doubt the development of the martial instinct of any race is essential to its self-respect. If there is one obligation more than another which we owe to Lord Palmerston it is that by his timely expenditure of eight millions of money he increased the self-respect, the freedom from panic fears and periodical fits of alarm and uneasiness that used to seize the public mind before we had the great defences which he developed. Lord Palmerston's care did not stop with Great Britain. Although the expenditure was comparatively restricted to home ports, a good deal was in fact expended abroad, and what is more, great designs were matured and prepared, and only need the purse strings to be opened to place Canada in the same position of security. The natural features of Canada are, of course, of an indelible character. There is the Lower St. Lawrence, which is the key to the whole position. There is the difficulty of defence of Western Canada, the certainty that we must concentrate our troops at three or four great points, and trust to the winter wearing out and exhausting the forces of any invader. There are martial instincts in the race developed by their particular phase of civilisation, the habits of daily life, which will make them one of the toughest people to conquer on the face of the earth, so that their conquest or annexation without their own consent seems to me a moral impossibility. Looking at it from that point of view I am delighted to hear my friend Colonel Strange bringing his great personal knowledge to bear upon the question to re-excite public interest in it, but I look upon it rather as a philosophical exercise than as a thing of great practical urgency. With regard to the North Pacific there is one of those questions in which a single generation of man has seen a most prodigious change. The last speaker might have included a coal-field between the Pacific and Upper Canada, namely, the coal-field of the Saskatchewan and Peace Rivers. I have visited that country, and can testify to the existence of coal there in large quantities. Nature has herself apparently pioneered the way for us by placing exactly where we shall some day want it, the stores of coal necessary for our purpose, and the iron will not be far off. But whether the Canadian Government should go into the vast expenditure which they are urged to do by the Columbians in completing the railway instead of letting time itself develop it, making it length by length, as is the plan of their able and sagacious engineer, is a point we might discuss for a great length of time without coming to any agreement. I have known Canada for 35 years, and the advance in that space of time is beyond anything to be easily imagined; not only its material advance, but also its advance towards those feelings on which national independence may be founded. They have no desire to be independent of us, and I trust that this generation will never see them so, but we must, of course, hold them with a silken string; and never was there a moment in which the loyal and popular feelings of Canada were stronger in favour of the Imperial connection than they are now.

General LOWRY: As one who knew Canada well some years ago I would like to say how entirely I go with Captain Colomb in the remarks he has just made, and how grateful I think we should all be to him and to Mr. Brassey for previous addresses here on this subject, and to the able lecturer of to-day—Colonel Strange—for calling public attention so forcibly to this matter.

Attaching myself the vastest importance to use being made of the present time

to prepare, in every possible way by land, sea, and lake, our Colonies for any emergency, I do hope that this subject will not be allowed to be lost sight of.

There can be none of much greater moment than that of a well-planned scheme of mutual defence and protection between Great Britain and her dependencies. Such a scheme would seem to promise to be best matured by due consultation—say by means of a Royal Commission—between the Imperial and colonial authorities. It will not do to attempt to improvise it when the emergency is on us. However it may be with us in “the old country,” our colonies are growing apace. If we look at the short span of time it took to make the United States the great nation it now is, it will not be by any means impossible to forecast what Australia, New Zealand, South Africa, and British America may—nay must—become even in the time of our children’s children! Why that part only of Canada known as Rupert’s Land is said to have increased by 20,000 inhabitants in course of the last year! And now, while the hearts of the people of that great dependency of British North America turn to us, as we have heard this afternoon, and as, I doubt not, do those of the people of all our colonies, with such loyal devotion, now is surely the time to lay deep and wide our plans for standing together as one great Empire for all time.

Colonel MONCRIEFF, F.R.S.: Permit me to remark upon one point brought forward by Colonel Strange, the construction of the great line connecting, what he happily named, the two nostrils of British America, viz., Columbia and Lower Canada. I have myself been in that central region through which this line would pass, and do not know any available country which, on the whole, is better suited for settlement by Englishmen. The vast and fertile undulating plains of the valley of the Saskatchewan, so accessible by a railway, and really so near to England, are, as it were, cleared by nature for settlement, and ready for the plough. A condition of things exists there which home statesmen do not realise, or else ignore, although they might have an important bearing on the crowded population of these islands. Certain classes of politicians—I do not say statesmen—in this country seem never tired of disparaging such questions, which they stigmatise as Imperialism, and constantly endeavour to concentrate public attention on home affairs, or on what Colonel Strange called the Home Empire, to the exclusion of the external or Colonial Empire, concealing the fact that the prosperity of the Home Empire depends, to a great extent, in these days upon the Colonial Empire, and is likely to depend even more in future on that, and upon the security of our great lines of communication.

That great territory, lying between the Atlantic and Pacific, offers not only a line of communication, but the very thing which is getting ever scarcer as our population increases at home, viz., land for the poor, and opportunities for a healthy agricultural population. Such opportunities, necessary for the moral and physical health, if not for political stability, are getting smaller in proportion as our population every year increases, whereas our available land here remains the same. In the healthy region through which this line runs there is ample accommodation for the surplus population of the United Kingdom for a very long time, where they could settle and prosper without changing their flag, to the mutual advantage of the colony and mother-country. I believe also that the construction of that Pacific Railroad has a strategical importance extending far beyond Canada itself, and which cannot easily be exaggerated. It quite startled me to hear the lecturer refer to a possible act of separation on the part of the Columbians. If such a thing were to take place, either by their own action or by external force, those coal-fields which Sir Henry Lefroy referred to as being of possible future use to this country, would be used against this country; certainly against those interests which the public are led to suppose will be conserved by confining our action within our own seas. I trust this paper will find its way to the ears of the public, and help to enlighten them as to who their best advisers are, viz., those who confine their views to what is convenient and immediate, or those who also embrace the whole Empire, and provide for the future.

Captain P. H. COLOMB: I did not intend to speak on this paper, which is really a military paper, but some remarks which fell from my gallant friend, Sir Henry Lefroy, in reference to what my brother said, make it necessary that some speaker

should draw attention clearly to the difference that might appear to exist between them in reference to the Pacific Railway. Sir Henry Lefroy spoke strongly, and I think we all went with him, as to the desirability of insuring peace by the multiplication of commercial ties. As I understood my brother's remarks, he wished to point out that from the transference of commerce, first to the Mediterranean, then to the Atlantic, then to the Pacific, the fact was that the commerce of Australia was drawing more nearly into and through the United States. Of course a cosmopolitan would say at once that that was of minor importance, because the great thing was the general progress of the world. I myself am not quite a cosmopolitan, and so if it be the case that the commerce of the East and of Australia is drawing more and more to the United States, then I say I think those under English dominion are very nearly concerned in drawing the commerce through their own territory. However satisfactory it may be for the general welfare of the world, I think that we Englishmen have a distinct interest in drawing commerce by means of the Pacific Railway through our own territory to our own shores, because I take it that if the commercial routes get entirely fixed *via* the United States, the result will ultimately be that there will be no use for that railway at all, and that any strategic value it might have, would be lost, because it would be impossible to make the railway only on that account.

Sir HENRY LEFROY: I may state that when I was at London about a year ago, there was a train for San Francisco actually at the station when I arrived there, so that the commerce of the Pacific does flow through Canada.

Captain J. C. R. COLOMB: I spoke of the trade and commerce of the Pacific in regard to Australia, China, and Japan, and that is being every year drawn more and more, not round the Horn, not through the Suez Canal, but towards the United States.

Admiral Sir COOPER KEY: I should like to ask Colonel Strange one or two questions. I think he stated that the Marine Militia in Canada did not exist, although provision for it was included in the Act of Parliament for the formation of the Militia in Canada. Will he kindly tell us if he knows the reasons why it is not in existence—whether it is because of the expense, or because of the indisposition of the people to enter into the marine service: or whether it is because the Canadian Government do not consider it of any importance for the defence of the country? Then I would ask, is there any elementary torpedo school, or any idea of forming such a school in Canada? Is there any preparation for torpedo defence of the St. Lawrence? And, further, what number of rifles are there in store in Canada, and of what description, Martini-Henry or Snider? I am very glad to have an opportunity of confirming what I have heard from Colonel Fletcher and Sir Henry Lefroy as to the admirable organization of the artillery in Canada under Colonel Strange. I had two opportunities of witnessing its practice and inspecting the system adopted, and I can speak most strongly of the delight I felt on seeing the perfection to which it had been brought under his care.

Colonel STRANGE: I cannot speak decidedly as to the causes of the non-existence of the Marine Militia. I should think it was certainly not due to indifference or apathy on the part of the marine population, either of the seaboard or of the great lakes, because, as probably the Admiral knows better than I do, the Nova Scotian fishermen have always had a great reputation for hardihood and daring, and I believe the lake sailors are not far behind them. The true cause I take to be a question of money. As regards the torpedoes, there is no organization whatever. On one occasion, when it was suggested to me (not to set the St. Lawrence on fire), but to clear it from ice, I obtained from the Corporation of Quebec five charges of gun-cotton, weighing 50 lbs. each. I placed these charges under the ice and exploded them by electricity, carrying it out as a means of instruction to the Artillery Officers and the men under my command. I also applied to the Government to allow me to send Officers to Halifax to be instructed by the Royal Engineer in torpedo practice, but the question of expense again came in. I also, though I am by no means as well acquainted with the coast as the Admiral himself, did suggest in confidential reports to the Dominion Government the localities that I thought would be advisable for torpedoes, the means of preventing their being dredged up by covering them with a few light guns in position, and other details,

but I have heard nothing further on the subject. As regards the rifles in Canada, this point will be referred to in the next lecture. There are only 70,000 rifles in Canada, 40,000 of which are in the hands of the Militia, and about 30,000 are in store. They are of the Snider pattern, and I must say, considering the close character of the country, that the Snider rifle, which is a rough serviceable weapon, answers very well in the hands of the Militia. I should not like to see the Government of Canada investing in Henry-Martini's, but I am sorry to say they have already commenced to do so. They have now obtained a few Martinis, and have in consequence a mixed arm and a mixed ammunition, with all its disadvantages, but I was not consulted on that point, nor the General commanding, apparently, as he condemns the purchase in this year's report.

Commander GURDON, R.N. : I should like to ask Colonel Strange one question. Are the guns which he has informed us are mounted at the various batteries in the Dominion intended to be the permanent establishment of guns for those places? The Americans are the only serious foes we are likely to encounter in those parts. If we were to go to war with them we should have some very heavily armoured monitors brought against us, and *not one* of the guns that Colonel Strange has mentioned is capable of piercing those monitors.

Colonel STRANGE : In answer to Commander Gurdon, I must say I devoutly hope that the limit of the seaboard armament has not been reached. The guns at present in position are put there on the principle that half a loaf is better than no bread.

The CHAIRMAN : This subject has been so fully brought forward by Colonel Strange, and so completely discussed by the gentlemen who have taken part in the argument, that I have nothing to add. I can, however, fully corroborate all that Colonel Strange has said with regard to the quality of the material of the forces that are in Canada. I have never met with a finer set of fellows anywhere than the Canadians, especially the lumberers. I have met them in the bush; I know them well. They are magnificent men, capable of being brought into organization in a very short space of time. The great difficulty, of course, in Canada is the small number of these magnificent men, for the whole population is now below three millions, as against the enormous population of the United States. I beg on your behalf to return thanks to Colonel Strange for his admirable lecture.

SECOND DAY'S DISCUSSION.

Sir COOPER KEY : I should like to ask Colonel Strange if he has heard any confirmation of what I was very glad to read in the paper two days ago, that the desire for secession from the Dominion on the part of British Columbia has now entirely ceased, and that a promise has been made by the Canadian Government that the construction of the Pacific Railroad shall be taken in hand as soon as the scheme can be organized. I am strongly impressed with the necessity for the construction of this railway as a matter of Imperial policy for the defence of our colonies in general as well as for the commercial interests of our own country, and especially for the security and prosperity of Canada. It seems to me the duty of all Englishmen to advocate that measure as strongly as possible. How it is to be carried out is beyond our province to indicate. The Home Government cannot interfere with the internal administration of Canada, but I believe it is the duty of every Englishman to assist in promoting the construction of this line. As was remarked by Captain Colomb the other day, large sums of money and many valuable lives have been expended in attempting to discover a practicable north-west passage without success, though not without valuable result, while the same object would be obtained far more securely by the Great Pacific Railroad. I trust that we shall soon hear that this great work has been undertaken.

Colonel ALCOCK : Imperial duty is the principal point now as it was in the previous discussion when we heard the question asked : "What are Imperial duties towards the Colonies?" and no one gave an answer, and that for a very sufficient reason, which is, that it implies a policy towards the colonies, and a policy

requires the support of public opinion, and public opinion in this country is very gradually formed, excepting after an event and under the influence of some great and sensational occurrence; but the object of this lecture has been to anticipate dangers and difficulties, to forecast what may be likely to occur and what may require to be done. Our present colonial system began, as I believe, in 1837, when Lord Durham was sent out to Canada with very great powers to settle existing difficulties, and to that nobleman we are indebted for a system of constitutional colonies and their federation for defence, which is the subject of this lecture and discussion. The next great step taken was that in which the public denounced the idea that the colonies were an incumbrance and ought to be thrown over, in order that a greater home power might be kept for the purpose of influencing Continental affairs called foreign policy, if that did not mean international peace. The idea was as unsound as anything could be, and it could be shown to be so upon a military principle, because we act upon defensive and not upon aggressive ideas. We all know that on the Continent the Great Powers can put we may say 500,000 men under arms, with double that number of trained men as a reserve, and an equal number again ready to be called up by compulsory service, and there is the root of the whole question; it is the difference between the compulsory service and voluntary service. Everything with us must be voluntary, carrying it on to the colonies themselves, and what they do must be voluntary. Every colony, which from its voluntary power provides for its own defence, contributes its full quota towards the general Imperial safety inasmuch as it has done its part. With respect to all constitutional colonies the first consideration is whether they will fulfil their full duty of defending themselves, and Canada, which the gallant lecturer has brought so forcibly before us, has set a very strong example in that respect, and I think we ought all to be very much indebted to him for the able manner in which he has brought before us the facilities with which a railway may be built, and the facilities by which a military colonization can be effected, inasmuch as the two could be easily made to work together, and the system which men understand in a regiment should be used in the construction of a railway.

Captain J. C. R. COLOMB, R.M.A.: I quite agree with the observation of the last speaker, that if a colony has provided for its own defence it has done its duty, but the difficulty is to determine what is its own defence. If you take some of your own colonies that are now engaged in doing that very thing, and spending a considerable deal of money in their own quarter of our globe, you would find that they are doing nothing with regard to something vital to their own interest, and that is nothing for the protection of their enormous wealth passing over the sea. The real difficulty in the matter of this Pacific Railway seems to be one of money. I do not think it is a question of political feeling between the mother country and Canada at all. Canada recognises the necessity for this railway as vital to her future, but she has not got the money to make it. On the other hand, we in this country say it is a Canadian concern, when it is no such thing; it is a concern which is vital to our whole Empire, for by it we should obtain the shortest route for the whole of the Chinese, Japanese, and Australian trades. A question has been asked about the secession of Columbia, but behind that there is another question which really affects us with regard to Vancouver's Island, that is, the question of an Imperial dock. I dare say distinguished naval Officers here, do not know that British Columbia has already expended equivalent to 40,000*l.* in labour and plant in commencing the building of an Imperial dock. It is well that these things should be known, but those reports are not laid before Parliament, and the consequence is she has been placed in the position of commencing a dock which she cannot finish. She joined the Dominion on the condition of the Pacific Railway being made; the railway has not been made, and she has been left with this unfinished dock, involving expenditure of capital, on her hands, which unfinished dock she has offered to the Imperial Government. She has expended the money, and she says, "for goodness' sake take it off our hands, and complete it as an Imperial dock," and Admiral after Admiral in the Pacific has urged and pressed our Government about the importance to us of that position, and the necessity of having, 15,000 miles away from home, a place where we can dock a ship; but people in this country do not know it. The fact is we are afraid to look into the whole question, and the reason why we may lose this

whole province, the reason we are afraid to make such preparation to maintain our command of the sea in the North Pacific, is because we have not direct communication with it. Therefore the Pacific Railway becomes connected with the dock, the Vancouver Dock is, like the Vancouver coal, connected with our command of the sea in the North Pacific; the command of the South Pacific goes with it, and our Empire of half the world is at stake. Now we at home are much more interested in our own affairs than in the affairs of those who come after us, and therefore there is a view of this Pacific Railway I should like to bring forward. Colonel Strange has already dwelt upon it, but it is important in connection with the Pacific Railway and with colonization. What the colonies want is population, and what we have too much of in England is population. At the present time your food supply is in the hands of foreign Powers; but supposing this railway to be made, you would then have within 14 or 15 days of England this enormous British tract of the best food-producing land in the world, and which when got at, would I believe maintain its food-producing power against the whole world. There is plenty of evidence to that effect. You have got that British waste land close to you. You do not choose to make that railway to develop it, and to enable home population to get at it, you choose rather to say it is a Canadian concern. What is the consequence? As I said the other day, out of some 54,000,000 quarters of wheat imported into the United Kingdom in 1877 we got about 22,000,000 from America. A month ago you may have noticed in the papers it was discovered that a ring existed in America for buying up and controlling the export of the corn crop of the year, and if it had not been accidentally found out you would in this country have suffered from that by arbitrary rise in the price of your food. As long as English people are content to let their food come from a foreign country when they have got food-producing wealth of their own thrown before them by Nature, which they have only to pick up and make use of, they must remember this, that the control of their food will have passed out of their hands through their own blindness and neglect. Such a "ring" would be impossible in Canada if our food was produced there, because commercial transactions are guarded and protected by British law. It was stated in the discussion here the other day that we were to hold Canada and our colonies with a "silken string." I know it is a very popular phrase, but in using it we must remember that there are two ends to the string. It is not altogether a question for you, it is a question for the colonies at the other end as well; and when people talk of cutting colonies adrift they must remember also that if the present action of the United Kingdom be not worthy of its position as the head of the Empire, before much time passed, the colonies might in disgust talk of cutting it adrift. Therefore in talking about consolidation we must also talk about reciprocity of duties and obligations. If we desire to keep the colonies it must not be by a loose string, but by a firm hold at both ends, and by a mutual system of give and take. With regard to the "silken string" I think Officers of the Army and Navy should closely examine as to whether we are not getting a good deal of shoddy into that string; in fact it may not be silk at all. We have heard of these Canadian Schools of Gunnery, &c., those admirable institutions for which Canada and the Empire has been indebted to the energy of our lecturer and his colleagues. Many of you have read the admirable Prize Essays by Officers reared in those Dominion schools, and you must see there is coming on in Canada a school of highly-trained scientific Officers, and you say, "That is a very good thing; let them go on." I hope they will go on, and I am sure they will as long as they have Officers like our gallant friend. But you must remember at present your superior appointments in Canada are held by Imperial Officers sent from England. When you get a number of excellently-educated, admirably-trained military Officers of Canadian Militia as you have now growing up in Dominion schools at this moment, do you think that they will be content always to occupy subordinate positions in Canada? They will not; it is unnatural that they should. Therefore I say you have to look to that fact, and to treat them as Englishmen, and as much a part of England's military strength as if they were born in Middlesex. We know it is the ambition of Englishmen to rise to the highest ranks of their profession, but at present the highest military positions even in their own localities seem to be out of reach of the colonists. The Home Militia offers a road into the Army; but you shut the gate on Canadians by saying the

Canadian Militia shall not be a stepping stone for them into the Army of the Queen, and thus you bar them out. If the question of Imperial defence is ever to be settled on a durable basis it must be on broader principles than "silken string theories," and the question must be dealt with honestly, thoroughly, and truly.

Commander GURDON, R.N.: I should like to ask Colonel Strange whether any proposal has been brought forward in the Dominion House of Parliament for the supply of money to erect a small arms factory in Canada—whether if it has been proposed, it was rejected or not, and if rejected, by how large a majority? I had the pleasure of being here two years ago, when Captain Colomb read a very able paper alluding to Vancouver's Island and the Dominion. I then suggested that a garrison should be sent out from England, and I hoped that it might have been done. This garrison, for more reasons than one, should be composed of marines and marine artillery, so that they may be at the disposal of the Admiral in command of the station. I think Vancouver's Island, in the opinion of most people who know that part of the world, should be an Imperial colony, or at all events an Imperial garrison, the same as we have at Halifax on the other side. There are no docks of any description that we can go to, unless we go to the Americans at San Francisco. We have an enormous trade with the Pacific coast. I have seen 70,000 tons of British shipping lying in San Francisco at one time, waiting for wheat. Of course if war breaks out with America—we must allude to these questions in connection with that part of the world—that trade of course would go, but we should have to protect the whole of our shipping in the Pacific, and a great portion of our China trade on that side, and we have not a single dock that we could put our men-of-war into at all. It is absolutely necessary that we should get a supply of coal on the spot; that supply of coal can only be got at one place, Vancouver's Island. Therefore it is absolutely necessary that for military purposes those coal supplies should be properly defended. They cannot be defended without a garrison. Ships can do a great deal, but you must have a garrison to protect your batteries, and those batteries must be placed to protect your arsenals and coal supplies in time of war. There is no doubt that the construction of the Canadian Pacific Railway at any cost is an *absolute necessity* if we are going to maintain the Dominion of Canada. That view has been pressed on the Government again and again. There is no doubt that the Americans place every possible obstacle in our way to prevent the completion of the Canadian Pacific Railway, for this very good reason, that they know if it is not carried out soon, British Columbia must fall into their mouth like a ripe cherry.

It is no good shutting our eyes to a stern fact that the manufacture of cotton goods has ceased to be a profitable employment in this country. That means that an adult population of four millions in Lancashire and elsewhere will shortly lose their means of livelihood and have to be provided for otherwise; and all this time we have immense tracts of land in the Dominion and other colonies to which they might be drawn, the connection between the colonies and the mother country strengthened, and riots and perhaps far worse consequences avoided. This scheme could be easily carried out if the Government chose to make emigration a national measure, directed by themselves. They could raise a large loan at $3\frac{1}{4}$ per cent., paying the passages out of married couples, their maintenance for the first year, and the erection of the necessary buildings, the Colonial Governments on their side granting farms of say 200 acres to each married couple, the money expended by the Home Government being charged as a mortgage of 5 per cent. on the title deeds of these farms, repayable to the Home Government in terms of three, five, and seven years, the Colonial Governments being responsible for the collection and transmission home of the money.

Unless some measure of this sort is adopted very soon, with failing manufactures, a population thrown more every day out of employment, with a capital of nearly 500 millions locked up in machinery and buildings, &c., we shall have a very serious crisis in this country, and I see no statesman on the scene who is preparing for this difficulty, and has the pluck to propose a measure of this description to the country.

Colonel MONCRIEFF, F.R.S.: As so few people have visited that magnificent territory through which this railway is proposed to pass, I think it a

good opportunity to say a very few words about its character, having been there myself. When the line was drawn between the Canadian and American possessions, although the Americans as usual stole a march upon us and put it further north than was originally intended, it is a remarkable fact that the line in this longitude cuts off a very poor district lying between the Missouri and British territory, and which from the poverty of the soil cannot support more than a sparse population, whereas on the other or north side of the line you get into a better and richer country, embracing the Assiniboin and the two valleys of the Saskatchewan. That river is navigable for hundreds of miles, and will be a useful artery for commerce, its two forks running towards Winnipeg, and extending back west towards the Rocky Mountains, drain an enormous area. A great part of this area is capable of cultivation, and has many resources, among others coal. It certainly enjoys a healthy climate for our race. The climate in the valley of the Saskatchewan is better than that of Canada in the corresponding latitude, as the isothermal lines rise towards the west. I have known troops of horses in winter wandering there without any attention whatever in the bush; in fact twenty years ago, and it may be now for what I know, it was the custom of settlers in Selkirk settlement to send out large troops of horses to the bush, where they lived without any attention all the winter, and they were herded back when required for summer use. This splendid region is so little known and appreciated that the charge of making a railway through it, which would open it up and enormously increase its value, is thrown first by Canada on England for want of means, and then back by England on Canada for want of knowledge. My own opinion is that if the real facts of the case were known on the Stock Exchange and by our rich people, and if they knew the concessions of land which could here at once be made to the railway, instead of thus holding back, there would be a rush to secure shares in such an enterprise. So much for the scheme as a legitimate and ultimately profitable speculation. It is, however, on the ground of its Imperial and strategical importance that the strongest reasons for its construction are to be found. Here is a great field for our surplus population; and if England has not lost the Imperial faculty of organizing arrangements for her people, why should not some such scheme as that proposed by Colonel Strange for making the colonization, the military defence, the construction of the railway, and the proper and orderly government of that country go hand in hand be thus carried out? What has been said by other speakers and in the paper on the strategic importance of connecting "the two nostrils" of British North America I hope will rouse attention to this matter in the proper quarters.

Colonel ALCOCK: Colonel Moncrieff has touched upon a very important subject in mentioning the Stock Exchange, because the mistake that this country has made has been in investing money in foreign securities instead of investing it in Imperial, that is, in colonial securities; and to give the strongest possible instance with respect to a railway, the Russian railways have been built with English money, and but for that we should not have had the recent war. Russia would not have been prepared for it as soon or as well as she was, to say nothing of Central Asia and her progress towards the East.¹

Mr. YOUNG: I should like to express my own individual gratitude to Colonel Strange for the very clear and able way in which he has placed before us the professional aspects of this important question. He has shown us the great shortcomings which exist in carrying out the details of these military matters which are of such vital interest to Canada. The whole question seems to resolve itself into one of cost. How then is the money to be obtained for carrying out this most necessary

¹ Whether I am strictly correct or not in what I said about Russian railways, it will be admitted that they are strategical, and more for the movement of troops and artillery than for any remunerative purpose, while those in Australia, for instance, are for the development of the resources of the country, and the money expended on them by their Government is reproductively employed, and therefore to be preferred as an investment from a financial and philanthropic, as well as from a patriotic point of view.

T. St. L. A.

work for the proper defence of Canada? Is it to be thrown on the resources of the Dominion alone, or are we not rather as a people living under one Sovereign to recognise it as a question of Imperial, or I would rather speak of it as of national, importance. If that be so, I do not know how we can refuse to recognise our responsibilities with regard to it, and the importance of our doing what is required of us as a nation, in order to carry it into effect. The principal point dwelt upon in the discussion this afternoon has been the necessity of completing the Pacific Railway; and there is no doubt the Canadians are perfectly desirous of seeing it done; but they consider it impossible for them to do more than they are doing at present. Unless they can have the Imperial aid which I think they have a right to claim, it will be many a long year before that great and essential work is likely to be completed. In the meantime it is a most serious question to recollect that British Columbia, which is the terminus at the other end, is in great danger of taking some steps towards separation from the Dominion, and of falling into the hands of another nation. This is a very serious consideration for us to contemplate, and there can be no doubt that it is much more imminent than many people in England have any idea of. What is wanted, after all, is for some one on the part of those who profess to be statesmen to take a statesmanlike and comprehensive view of these matters. We are too apt in this country to look far too much merely to our local interests, and do not extend our vision to the more remote corners of our enormous Empire. But it will not do for us to continue to dwell in such a "fool's paradise" very much longer, or we shall be some day suddenly awakened to a very serious condition of things. The question of emigration has been touched upon. It is a national one. It does seem to me most extraordinary that we in England, who are continually complaining of our being overpopulated, and are constantly seeing the terrible distress that occurs in many of our great centres of population from an undoubted superabundance of people, cannot evolve some national scheme for taking that surplus away to the other parts of our Empire which are urgently wanting them, and only require them to be properly transported to their shores. These are questions which we must frankly face before long, and it is very desirable that so influential a class as military and naval men should turn their attention to them, in order to force the Government to take them up, in deference to enlightened public opinion, in a way which their paramount national importance demands.

The CHAIRMAN: I am not one of those who believe in the decadence of England, or in the incapability of our statesmen, our merchants, and our financiers to grasp a great idea and carry it out. Much that has been said of their folly and infatuation in not completing this Pacific Railway appears to me gratuitous and unfounded. There are enormous difficulties in the achievement of such a project; the idea of the Canadian Government is to execute the railway step by step, as there shall be a population to benefit by it, or as sections of 100 or 200 miles can be shown to be profitable; and if we only allow time, it will find its way by that process to the Pacific. But I must say, I for one should think it the height of folly on the part of the Canadian Government to rush into this great work in its entirety at the present time, or for any party of English statesmen, responsible to the people of England for their taxation, to volunteer to lend them 20,000,000*l.* or any similar sum that they might require. Gentlemen of the Stock Exchange can tell you something of the capital that has already gone to Canada for making railways, scarcely one of which at present pays. I think, therefore, we must be a little patient; we cannot anticipate what is really the work of the slow development of history. We have no more marvellous proof of the rapidity of that development than in the subject which has been brought before us by Colonel Strange to-day. It is but 40 years since a handful of French Canadians, on grounds so obscure that they are almost forgotten, half frightened us out of our senses lest we should lose Lower Canada, led to enormous and costly efforts to suppress them, and to the occupation of the country for the next 30 years by a strong Imperial garrison. Now the country is in a far more loyal position and temper towards the British Empire than it ever was before. It has developed what is a perfectly new thing in Colonial history, a regularly organized, well-conceived militia system, embracing every branch of instruction from the highest to the lowest, not realised perhaps as fully as it exists on paper; but there is the seed, out of which the matured plant may here-

after grow. Can we not be contented with that for one generation? Can we not let these magnificent dreams of empire work themselves out according to the destiny of nations? Where is the present danger? What was the condition of the United States itself in regard to its military armaments prior to the great contest of North and South? Why, they were as thoroughly neglected as they were in Canada; they thought themselves free from external foes, and therefore could afford to dispense with them. They have since developed them to some extent, but they are still, as measured by the scale of European preparation, in a very defective state. Canada can also afford to leave much that is in an abstract sense important, to be met when the necessity arises. Of course we admit the necessity of having a foundation laid to carry any future superstructure; but to say that everything that may have to be done in war is to be done in anticipation in time of peace, is to ask what no responsible statesman can agree to; and I do not think that any one of us, if we were addressing a constituency with a view to election to Parliament, would venture to adopt such a line of argument.

Colonel STRANGE: I thank you very much for the remarks that have been made, which I think are even more valuable than the paper itself. I have not heard that the secession question of British Columbia has been settled in Canada. Sir Cooper Key remarked that the English Government were not in a position to interfere in this matter. To a certain extent of course we all know that is quite true, but surely to purchase shares in a Canadian Pacific railway would be as legitimate as to purchase shares in the Suez Canal. Surely we are as closely connected with Canada as we are or might be with Egypt. I have also been asked whether there has been a vote before Parliament for a small-arms factory in Canada. The matter has never been brought before Parliament. I have urged it in Official Reports, in Blue Books, which are laid before Parliament, but apparently never read.

With regard to Sir Henry Lefroy's remarks, I am not in a position exactly to answer them. I know his long familiarity with the country and his great wisdom, and it would seem presumption for me to say anything on the subject in the way of reply. He alluded to the Rebellion of 1837, as giving us 30 years' military occupation and trouble, but another speaker pointed out it was the want of considering what the French Canadians wanted in time that was the cause of all this, and Sir Henry himself has alluded to the marvellous development of things now-a-days that requires us to be up and doing, and will not allow us to drift as we used to drift in the old times. He spoke about American people not having military institutions and organization until the Civil War obliged them to; but would they have had any civil war at all if they had thought about it a little beforehand? Then as to the security of money lent to Canada, I have already referred to the difference between the Pacific and the Grand Trunk, in which the English people took shares, and in which Canadian people had scarcely any shares at all, and in which there were not vast tracts of rich arable alluvial land to give away. If the Saskatchewan Valley is as everybody says it is who has seen it, a rich fertile alluvial soil, where there is coal cropping out from the banks of the river ready to be used, I must submit, with all the rashness of youth, I cannot see any reason why this railway should not be made.

The CHAIRMAN: I think I may venture in your name to return to Colonel Strange our hearty thanks for a most interesting, original, and thoughtful paper. I should answer Colonel Strange's last remarks about the Saskatchewan, by saying I have had no other feeling than a wish to dispel illusions. When you talk of the Saskatchewan and talk of many thousands of square miles of territory, no doubt in those thousands of square miles there are fertile tracts where grain can be raised, and there is some indifferent coal. But it is a great mistake to suppose that the whole region is so fertile, or that the climate is altogether such as Englishmen would delight in. I think I may express our united hope that Colonel Strange, in returning to Canada and to his very important duty there, will return having his hands strengthened by whatever moral influence our approval and respect for his energy and zeal can afford him, and that he will be enabled in his future negotiations with the Canadian Government to carry, as well as he deserves, a greater degree of weight than appears to have been hitherto given to him.

LECTURE.

Friday, June 6, 1879.

LIEUTENANT-GENERAL SIR DANIEL LYSONS, K.C.B., Quarter-Master-General, in the Chair.

MILITARY TRANSPORT.

By Lieutenant-Colonel CLIFFORD PARSONS, Professor of Military Administration and Law, Staff College.

AMONG civilized nations in modern times, one of the principal difficulties which military commanders in the field have to encounter is the adequate supply of their armies with food and war material. In most instances it is not that supplies of either kind cannot be provided by the State, but that their conveyance to the spot at which they are to be consumed constitutes the real difficulty. It is quite unnecessary to dwell upon this, as almost every telegram from the seat of war on the borders of Zululand reminds us of it constantly. Nor are difficulties of this description confined to any particular instances; the well-known paragraph, "Great efforts are being made to overcome the transport difficulties which stand in the way of an early advance," or this day's version of it, "Owing to the difficulties of transport no infantry can enter Zululand beyond Landsman's Drift at present," might have been written of many similar undertakings.

Both in Abyssinia and Ashantee abundance of supplies could be brought to the base of operations, but the provision and maintenance of the means of transport inland caused serious anxieties and delays.

Again, on a larger scale, and for a more extended period, our maritime resources enabled us to convey to Balaclava almost all that was necessary for the army before Sevastopol, yet the troops, only six miles distant, endured great privations for many months from want of adequate means for distributing the supplies.

The general subject of military transport, omitting altogether transport by sea, which does not come within the scope of my lecture, may conveniently be divided, in the first instance, into: 1st, Inland water transport, that is, by means of navigable rivers, lakes, or canals; 2nd, Railway transport; 3rd, Transport by means of wheeled vehicles on

¹ *Standard*, May 27, 1879. *Daily News*, June 6, 1879.

common roads; and, lastly, by means of pack animals or human carriers. Of these, water transport is the easiest to provide and maintain under all ordinary circumstances where suitable inland water exists; it is also the most economical, and most suitable for heavy weights, such as are involved when siege trains, their ammunition, and other appliances have to be transported. It is calculated that a horse can draw twenty-five times as much on a canal as on an ordinary road.

In former times, before the introduction of railroads, the direction of navigable rivers had a considerable influence on the strategy of a campaign, as forming part of the line of supply. In the Peninsula, the Tagus and the Douro, for considerable distances, were thus utilized, and we find the Duke of Wellington making continual efforts, in the course of the war, to improve their navigation. The same, of course, applies to more recent operations in countries where railways are not available. As, for instance, in China, in 1860, the use of part of the river Peiho, as far as Tungchow, where it ceased to be navigable; and in New Zealand, in 1861, where river transport was available at intervals on the line of supply. Again, in the Franco-German War, the collection of supplies at Coblenz, Bingen, Mainz, and other places, to feed the enormous armies concentrating on the Rhine, was mainly performed by steamers bringing provisions purchased in other countries. Inland water transport, however, has some disadvantages which may become serious under certain circumstances, if it is intended to rely mainly upon it. In the first place, it is very easily interrupted; if the enemy should gain possession only for a few hours, and by a very small party, of any part of the water communication, he may so use his temporary advantage as to render navigation impossible for a considerable time afterwards. In a very short time the navigable channel of a river may be blocked by sinking a few laden vessels or barges, which it may take weeks to remove. Some of the locks, or part of an embankment, of a canal may be destroyed by a few charges of powder, or it may be made useless by diverting the channels by which it is fed with water.

For military transport railways are superior to canals in two or three important particulars, their greater speed not only renders them far more efficient for purposes of supply during the continuance of operations, but also enables them to be used for the transport of the troops themselves in effecting their concentration at the outbreak of hostilities. Within reasonable limits railways may be erected or extended either preparatory to or during the course of military undertakings; the first occasion on which this was put in practice was in the Crimea, where about four miles of railway were constructed, from Balaclava to the army before Sevastopol, for the transport both of food and siege material. In Abyssinia about 11 miles of railway were laid from the port of disembarkation; and in the Franco-German War the Prussians constructed a loop line more than 22 English miles in length, from Remilly to Pont-à-Mousson, so as to avoid the fortress of Metz, which blocked the line. The railway from Balaclava to the front was worked in sections as follows: a locomotive

drew the train for two miles in the plain where the ascent was moderate, a stationary engine then drew it up an incline of $\frac{1}{15}$ for a third of a mile, eight trucks being brought up at a time; two trucks at a time were then drawn by horses up an incline of $\frac{1}{25}$ for a mile and a half.

In the report furnished with reference to the Abyssinian line, it appears that the working by a civilian staff was very unsatisfactory, and that casualties and dismissals were very numerous; it was then recommended that, in future, men from the ranks of the army should be employed to the greatest extent possible, and the opinion was expressed that engine drivers and foremen platelayers were the only skilled workmen who could not be supplied from the army or from the navy. This line took about four months to construct.

It by no means follows that, when we have to construct railways under similar circumstances, we need adopt the pattern in common use for commercial purposes; there have been many descriptions of light railway produced of late years by able engineers, into the technical merits of which it is not my province to enter. Doubtless a choice could easily be made from among these inventions, and indeed certain constructions of this nature have already been experimented upon. Thus by transporting to the base a moderate amount of material, a useful railway on a small scale might be constructed within a short time, along some part at least of the line of communication. That it should be available at an early stage of the undertaking is an essential feature in the utility of a railway under such circumstances, and the possession of a light line at the very commencement has the additional advantage of facilitating any further constructions that the magnitude of the operations may require.

Railways are equally vulnerable with canals, although it would under most circumstances be more easy to re-establish traffic on a damaged railway than on a damaged canal. Both these modes of transport have the disadvantage of being confined to particular localities. A most able paper on railways as affecting the provision of other army transport was written by Lord Strathnairn, and appended to the report of his committee in 1867; he clearly points out that no general could dispense with his ordinary military transport, because he could at some period of his operations make use of a railway; and argues that, pre-eminently useful as was the railway during the siege of Sevastopol, all its utility would have vanished with a change in the scene of operations. Moreover, experience clearly shows that railways, where they exist, cannot take the place of the ordinary military transport for the distribution of supplies to a large army; first, because it is not considered expedient to carry railway transport too close to the sphere of action, for fear of losing the supplies which must necessarily accumulate at the terminal station, in the event of a retreat or even a small retrograde movement becoming necessary; and next, because it would be impossible to find railways ramifying to all, or even to many, of the fractions of an army of any magnitude, covering perhaps many miles of ground. About one day's march from the army itself was usually considered by the

Germans in 1870, to be the nearest point to which railway transport should be used.

Practically then the principal use to which railways are applied in war after the forces are concentrated, lies in replacing the long lines of wagons passing between the base of supply and the advanced magazines of the army; for this purpose, however, their importance can hardly be overrated when we consider that a very ordinary goods train, such as we see on our lines every day, say 30 trucks carrying an average of eight tons each, conveys as much as 160 fully loaded general service wagons, and will transport the supplies to at least ten times the distance in the 24 hours, allowing the widest margin for delays. Thus, as a minimum estimate, and without taking into account numberless other details which tend to augment the difference, a railway train may safely be said to be equal in transport-power to 1,600 wagons. The German armies around Paris were kept supplied with all they needed by one railway running from 12 to 14 trains a day, at a time when the resources of the country had ceased to contribute to their support in any material degree. General Bronsart von Schellendorff, chief of the staff of the Guard Corps, in his admirable work on the duties of the general staff, estimates a train load at about 246 tons English, equal to two days' rations and corn for an army corps, including its cavalry division, a total of about 37,000 men and 10,000 horses. The military use of railways is in itself a subject of so wide a scope that were I to attempt to discuss it in any detail, it would be to the exclusion of the other branches of military transport to which I must now more particularly confine my remarks.

The relative merits of *draught* and *pack animal* transport have long been a matter of controversy in our army; our experiences of warfare have been, and for the most part may be said still to be, so different from those of continental nations that we naturally view the subject in somewhat a different light. In the great wars of the early part of this century, a time when military organizations were first assuming something like their present type, our operations were chiefly confined to the Peninsula, a country exceptionally rugged and ill-provided with roads, and where commerce was mainly carried on by the use of pack animals. We naturally imbibed the idea, which lasted for so many years afterwards, that there was no means of transport so applicable to military operations as pack animals. The regulations for the supply of military stores to an army in the field, dated 1866, now obsolete, bear ample testimony to the vitality of this idea. Other nations, guided by the light of their experiences of campaigning in central Europe, upheld the use of wheeled carriages, the superiority of which is unquestionable wherever the roads are sufficiently good to admit of their use. The effective wagon-load being from 25 cwt. to 30 cwt., and the average load of a pack-mule, exclusive of the pack-saddle, 160 lbs. or thereabouts, it follows that a wagon carries as many rations as sixteen or seventeen pack-mules; nor does this statement truly represent the economical difference between the two, as food for the animals themselves, either wholly or in part, must in very many

instances be also carried. A simple example, denuded of all contingent intricacies will, I think, best serve to illustrate the state of the case.

Twenty days' complete rations for 10,000 men have to be collected within ten days at an advanced depôt three days' march from the base of supply, there being neither provisions nor corn procurable by the way. Each mule is to carry a load equivalent to 52 rations, or as nearly as possible 160 lbs., besides his own trappings. To effect this within the time allowed, 385 mules must deliver their loads at the advanced depôt each day, and, as food for the animals and their attendants halting there for the night must also be carried, at 10 lbs. per mule and 3 lbs. per man, 30 mules must be added for this purpose, making the number 415. Supposing A to be the base of supply, B and C the intermediate stages, and D the advanced depôt, the calculation will be as follows, viz. :—

	No. of mules.
Halting every night at the advanced depôt, D	415
At C there will be the following numbers every night :—	
Returned from D, and ready to go forward again	
on the morrow	415
Arrived from B with the supply for D	415
Ditto with corn and rations for the	
station C itself	63
Total halting every night at C	893
At B there will be the following :—	
Returned from C and to start again on the morrow	478
Arrived from A with the supplies for D, and also	
for the station C	478
Arrived from A with corn and rations for the sta-	
tion B itself	72
Total halting every night at B	1,028
At A there will be the number returned from B, and ready	
for to-morrow's journey	550
Total, without any allowance for casualties	2,886

A, B, and C would be the head-quarters of each stage, and the allotment of animals would be—to A, 1,100; to B, 956; to C, 830.

Considerable numbers would have to be added as a reserve to meet emergencies, and to allow for the proper percentage of sick, probably not less than 25 per cent. both for sick and days of rest, of which as many as possible should be retained at the base of supply until required, in order to save the transport of their forage, &c. The illustration is merely intended to show the elements which tend to swell the numbers when pack animals are employed.

Now to compare this with the same operation performed by four-

horse wagons, each carrying, say, the moderate load of 25 cwt., or as nearly as possible 910 rations. Supposing all other arrangements to be the same, and the details calculated in a manner analogous to the last case, it will be found that 144 wagons with 576 horses, 50 wagons being allotted to A, 48 to B, and 46 to C, will perform the same work as the 2,886 mules, omitting all mention of the diminution in the number of attendants, the care of sick animals, and the difficulty of supervision.

In addition to the foregoing considerations, pack animals undergo a great deal more fatigue than draught animals in performing their quota of work; each time a short halt takes place the draught animal experiences relief, whereas the other still bears his burden; and in cases where the baggage-trains must be held in immediate readiness to move, pending the result of some tactical operation, the pack animal must remain loaded for hours, as the loading cannot hastily be performed, for on the careful adjustment of the load depends the preservation of the animal's back and his general condition for work. The average percentage of sick among animals performing transport work in a campaign, is estimated at 10 per cent. for draught, and 15 per cent. for pack transport.

There is, on the other hand, a good deal to be said in favour of pack transport. In the first place, our armies have very often to operate in countries impassable by wheeled carriages. This argument is, of course, conclusive for such instances, and, even where good roads exist, troops often get separated from them, and if the country is rugged, can be reached only by pack animals. This must often be the case with individual battalions, which may thus be deprived of access to their regimental reserves of ammunition and their intrenching tools at critical moments.

Again, it is urged in favour of pack animals that roads have frequently become blocked by carriages, and the only method of bringing up supplies has been by pack transport. Casualties of this nature occurred in the Austrian campaign in Italy in 1859; and it is sometimes advocated that means should be provided for the conversion of the draught animals into pack animals for such occasions; but, in addition to the extra trappings that must be carried continually, so as to be ready for an emergency of this kind, there is the difficulty that horses require a considerable amount of training before they will carry a pack-load quietly. It is, I think, worthy of note, as applicable at least to operations in central Europe, that the Germans do not admit that there is any necessity for providing pack animals, all their transport being by means of wheeled carriages. As regards our own service, and considering the exceptional conditions under which our expeditions have generally to be undertaken, it appears desirable that the tables of transport allotted to each of our units of organization on its war establishment should show alternative scales, the one to apply when wheeled carriages can be used, the other when pack transport is a necessity. These should be ready prepared, not only because the number of animals to be provided would differ enormously, but because the composition of the *personnel* in drivers, supervisors, and artificers

must also materially differ. I am given to understand that some steps in this direction are likely to be taken.

For purposes of calculation, pack-loads, including the trappings, may, under ordinary circumstances, be estimated as follows: viz., horse, mule, or bullock, 200 lbs.; camel 400 lbs. to 450 lbs.; donkey 140 lbs.; elephant 15 cwt. to 1 ton.

The horse, mule, pony, donkey, camel, and elephant are all good pack animals; the mule is better for pack transport than the horse, being more sure-footed, more hardy and enduring, and more easily fed. The bullock is inferior in this respect, though often used in India, and employed to some extent in Abyssinia; as a draught animal, too, he is very slow.

The elephant will not stand fire, and, in consequence of this defect, when elephants have been employed for artillery purposes, a sufficient train of bullocks to bring the guns into action has been provided in addition. This was the case in Abyssinia, and at this moment the two heavy batteries (40-pr. Armstrong and 8-inch mortars) belonging to the Quetta Army operating against Afghanistan, have each nine elephants for transport, and 300 bullocks per battery to bring its six pieces into action. The camel is invaluable as a pack-animal, but those used in plains are unsuitable for rough work in hilly country, for which special animals should be obtained. The camel is easily managed and fed when in health, but delicate and difficult to cure when once on the sick list. It has been suggested, by a most able officer in India, whose past experience entitles him to attention on all matters relating to military transport, that it would have been better for us had we, in the present Afghan expedition, trusted more to the mule and less to the camel than we have done.

Time will not allow me to enter into details connected with the peculiarities and management of transport animals. The "Soldier's Pocket Book" contains some concise information concerning them, and Major Furse has dealt with this matter at greater length in his "Studies on Transport." A great deal of information relative to the treatment of the elephant was furnished by the Government of Bombay, for the guidance of the commissariat officers in the Abyssinian expedition, and is to be found in the official account of the same. It seems very doubtful whether the guns could have been transported to Magdala without the assistance of the elephants, 44 of which were landed at Zulla, and the greater number handed over to the artillery.

When transport has to be performed by human carriers, as was the case entirely in the Ashantee expedition, and partially in many other of our operations, as in China, in 1860, and for the Duffla and Looshai expeditions in 1874, there are many points to be considered, which do not enter into the question when other animals are employed. The weaknesses, prejudices, and inclinations of human nature come prominently forward; four-footed animals may break down or even stray, if not properly looked after, but they cannot lay systematic plans to desert in order to avoid distasteful labour, or for fear of their employment leading them into danger. Very large numbers of carriers were lost to

the service by this means, in the earlier part of the operations in Ashantee, and the evil was only alleviated by the exercise of great judgment in their management. Experience showed that the indiscriminate mixing up of men of different tribes in the same companies or gangs did not answer. It was found that the overseers of gangs must be selected, as far as possible, from the same tribe as the bulk of the carriers, in order to be able to control them; and that the carriers showed less inclination to desert when they were worked on the stage system, so that they could, in many instances, return each night to their station, which was very often not far from their own villages.

The load for a carrier, both in China and Ashantee, was 50 lbs., but it did not always quite amount to that. In the Duffla and Looshai expeditions the regulation load was 40 lbs. As it is evident that a fixed weight must be determined upon, so that arrangements may be made for having the stores packed in corresponding quantities, there is much to be said in favour of the smaller load. In the first place, it is not excessive when a longer or more difficult march than usual has to be made, or when women or weakly men have to be employed; and, in the next, the load is more capable of being adjusted to the requirements of the case; on short marches, easy roads, or on great emergencies, four loads may be given to three carriers, or even three loads to two carriers, the extra load being carried alternately, or by any other arrangement suitable to the particular method of carrying adopted by the men.

A most important feature in pack transport is the pack-saddle, an unfortunate selection in this respect has been found from experience to be more instrumental in destroying its efficiency than perhaps any other single cause. A bad pack-saddle will inevitably give the animals sore backs, when they become useless for considerable periods, during which, however, they necessarily require attendance, and other animals must in many instances be employed in bringing them their food. It is often found advisable to adhere to the saddle to which the animal is accustomed, and which has doubtless been found suitable to the country in which he has been obtained and performs his work. This, however, cannot apply to the thousands of horses and mules purchased for an expedition from widely different sources, and arriving without any equipment at all at the base of operations. We have now an excellent general-service pack-saddle of a kind used largely and much approved in the Abyssinian expedition, and which has since undergone various improvements. It is known as the Otago pattern; there are two sizes, one for large or medium, the other for smaller animals, weighing respectively, with all other trappings, $44\frac{1}{2}$ lbs. and $38\frac{1}{2}$ lbs. The saddle has a comfortable seat, upon which, when no other load is carried, a man can be mounted.

The next point for consideration is the description of wheeled carriage most suitable for general military transport. The qualities essential for a good military carriage are the following:—Interior capacity to receive, and strength sufficient to convey its load under ordinarily difficult circumstances; stability, that it may not easily overturn on rugged roads; lightness of draught; facility of turning

within a moderate compass; durability; simplicity of construction, so as to be easily repaired and easily packed for shipment; and, lastly, lightness of construction, as far as is consistent with the requirements just enumerated.

There have been endless controversies as to the relative merits of four-wheeled and two-wheeled vehicles. The evidence given before Lord Strathnairn's Committee in 1867 furnishes abundance of arguments on both sides. The principal merits ascribed to the two-wheeled cart with two horses are, that the horse draws to more advantage, being closer to his load; that it is easier driven and can be turned easier than the wagon; that it can go over worse ground and is easier extricated from a difficulty; that it carries at least as much in proportion to the horses employed; is more simple in construction, and therefore more easily repaired; and that it is more easily stowed on board ship.

The chief advantages claimed for the four-wheeled wagon with four horses are that the animals suffer less wear and tear in doing their work, and that a less number of them are liable to sore backs; that the wagon is easier to load, as less accuracy in distributing and balancing the weight is requisite; that it takes up less room on the line of march with reference to the quantity carried; that the loss or breakdown of one of its horses is of less importance, as it could proceed with three, while the cart with half its draught-power gone might be lost; and lastly, that a less number of drivers are requisite.

The vehicles in general use in the country where an army is operating must always constitute a very considerable part of its transport. It is utterly impossible to supply from home more than that required as regular military transport accompanying the troops, and for the divisional and army corps establishments of various kinds. The immense amount of transport to maintain the supplies along the line of communication must always consist of such vehicles and animals as can most easily be obtained by purchase, by hire, or by requisition, and must often be of a very miscellaneous kind. There is little to be gained by discussions as to the suitability of the local transport when no other is to be had to the extent required; it generally happens that it is fairly suitable; sometimes, indeed, it is found superior in its own country to any other that can be supplied from a distance. This appears to have been the case in the Red River expedition, where the two-horsed wagons commonly used throughout Western Canada were employed. These, as Sir Garnet Wolseley himself states, stood the work over the extremely rough roads very well, while the two-wheeled carts provided for the occasion were found unsuitable.

The different descriptions of transport vehicles required for military purposes are very numerous, as almost every special service necessitates a specially constructed wagon; thus in the Engineer service alone there are no less than nine descriptions of carriages employed—the pontoon wagon, the trestle wagon, the telegraph-wire wagon, the office wagon, the photographic wagon, the miners' wagon, the store wagon, the forge wagon, and the tip-cart. For the medical department there are the ambulance wagon, the pharmacy wagon, and the

water-cart, &c. It would, however, detain you too long to enter into details of this kind; the able treatise on military carriages by captain Kemmis, royal artillery, published under the authority of the war department, describes fully both the principles and the details of construction of every military carriage produced by the royal carriage department, and to this work I must refer those who desire to go deeply into these particulars.

There is, however, one carriage the use of which is so general that it deserves particular notice; it is that known as the general service-wagon, designed, as its name indicates, for the conveyance of every description of stores and supplies for which special vehicles are not necessary. The latest pattern to govern future manufacture is that dated July, 1875, known as Mark IV. Its general construction is very similar to that of previous patterns; the fore-carriage locks completely under to facilitate turning, the equirota principle—that is, with all the four wheels of the same diameter—upon which some older patterns were constructed, having been definitely abandoned. It is fitted with floating raves, movable bale-hoops and cover, and with a driving box and footboard in front. The capacity of its body is, length, 9 feet 8 inches; breadth, 3 feet 8 inches; depth, 1 foot 8 inches, or 59 cubic feet; the height from the floor of the body to the top of the bale-hoops is 4 feet, giving a total interior space, up to the cover, of about 120 or 130 cubic feet; its full load is about 30 cwt. It is not a spring wagon, its wheels are of the sizes now adopted for almost all our military carriages, viz., 4 feet 8 inches, and 3 feet 4 inches, in diameter, their track is also the same, viz., 5 feet 2 inches. The weight of this wagon is a trifle under 18 cwt., it can be very easily fitted as a forge-wagon when necessary. On service and when fully loaded, it is drawn by four horses on the shaft principle, each of the near horses being ridden by a driver, as in almost all our carriages of the regular military type. Driving with reins from the box can, however, be resorted to when it is expedient, sets of reins being now provided for the purpose. In the opinion of many of our officers most competent to judge, this mode of driving might, and probably would, be largely resorted to when travelling on good roads, as a saving to the horses and a prevention of sore backs, but I think it is generally admitted that for transport that must of necessity accompany the troops, be the roads good or bad, the postillion fashion should be maintained, as by it difficulties are surmounted which would be insuperable to wagons driven from the box.

With reference to draught-power for transport purposes, the time has come when the traction-engine must be reckoned as one of the auxiliaries. On account of the paucity of horses in Italy, especially of the kind fit for heavy draught work, the Italians have introduced the traction-engine as part of their military transport, the long level roads of northern Italy being favourable for the purpose. They were apparently first used experimentally in 1874 and 1875, in the neighbourhoods of Turin, Verona, and other large garrisons, and since then their use has been extended at each of the subsequent annual manoeuvres, being confined to the supply columns in the rear of the army. Considerable improvements have taken place in the construc-

tion of the engine. From the best available sources of information, it appears that the latest that have been purchased are engines of about six horse-power, able to draw about ten four-horse wagons on a moderate road at an average speed of three miles an hour, and able to maintain this if necessary for about 16 hours. The engine is fitted underneath with a windlass and coils of strong chain or wire-rope, from 80 to 100 metres long, by means of which it is enabled to extricate wagons or heavy guns out of difficulties, and even, by making fast the end of the chain, to surmount steep and rugged pieces of road by the simple process of winding itself up by successive stages.

Traction-engines must of necessity be confined to the best roads, as they would very speedily destroy any road with a light foundation; there is, moreover, considerable difficulty and delay in causing an engine with its train of wagons to turn sharp angles where one road joins another, thus their utility is much restricted. In our own case it will probably be found that their principal use will be for work in connection with the wharves or other landing places, and the stores established at the base; perhaps also, under favourable circumstances, for the working of the first stage or two forwards; because at or near the base labour is more easily obtainable for keeping in order the roads upon which the engines would travel, and there also the greatest demand for transport occurs. It seems that on some occasions the working of the traction-engines during manœuvres in Italy has been less satisfactory than at others; this has been attributed mainly to want of knowledge and skill on the part of the drivers, and steps appear to have been taken to keep a sufficient number in training.

Having thus far touched upon some of the principal details, we must now turn to what may be deemed the broader side of the question, namely, the organization of military transport.

It is a well recognized principle, founded not only on the experiences of modern warfare, but on the opinion of the ablest commanders of a past generation, that the transport service with an army, to be efficient, must have a military organization. The adoption of this principle has gradually brought about, both in our own and in other European armies, the division of transport into three classes, viz., regimental, departmental, and general transport.

The regimental transport is that which is placed entirely under the management and control of the commander of the battalion or other unit, for the purpose of meeting its immediate wants; subject to the contingency that, when this transport is not actually required for marching purposes, it may be made available for services of a general kind, either wholly or in part, as may be deemed expedient by the commander of the brigade, the division, or the army corps. A British battalion on its war footing, assuming that in an undertaking of any magnitude in Europe tents could not accompany the force, has twelve transport carriages, viz., two wagons for regimental purposes generally; two for provisions, carrying at least a day's rations; four company wagons, that is, one for every two companies; three ammunition carts, carrying the regimental reserve of 30 rounds per rifle; and one cart for intrenching tools, of which it carries 300, picks and shovels

together. A cavalry regiment is very similarly equipped, having, however, a field forge in place of a tool cart, and but one ammunition cart; thus its carriages are ten in number. A battery of artillery has four carriages in addition to its guns and their ammunition wagons. Under the present system for providing and maintaining regimental transport the battalion or regiment furnishes out of its own ranks the officer, sergeant, and 22 drivers required for that service, the men receiving such previous training as may be possible at some station where there are companies of regular transport in garrison; the horses are supplied through the agency of the Commissariat and Transport Department; the wagons and other material by the Ordnance Store Department. By a recent regulation, the nucleus which the regiments of cavalry and battalions of infantry first for foreign service hitherto maintained as a groundwork for expanding their regimental transport, has been withdrawn; each cavalry regiment, however, is allowed four squadron carts on its peace establishment, to be used with troop-horses when required.

There are officers of great experience in the service whose opinions are highly valued on such subjects, who advocate a change in this respect. They suggest that the whole regimental transport establishment should be supplied complete from the Commissariat and Transport Department, being attached to the battalion for duty, discipline, &c., but remaining under the supervision of the department for administrative and technical purposes; the advantages to accrue being, that effective soldiers need not be withdrawn from the regimental ranks for transport purposes; that battalions would have an efficient transport at an earlier period on mobilization; that the transport could be better looked after in technical matters by proper transport officers; and that when utilized for general purposes, apart from the battalion, it would work more harmoniously with the rest of the departmental transport. On the other hand, even supposing that the department could furnish all that is necessary at a moment when demands upon its resources are pouring in from every quarter, and its own requirements are at a maximum, I fear that the *personnel* would find themselves in the position of men with two masters, and the proverbial consequences would follow. The evil of denuding the ranks of efficient soldiers unquestionably requires a remedy, which could doubtless be applied without so radical a change; and I can see no reason for supposing that any difficulty would arise in temporarily gathering together and utilizing for general purposes such portions of the regimental transport as would otherwise remain idle during a prolonged halt, or under any other similar circumstances, provided it is worked under its own officers or non-commissioned officers, and in larger undertakings under the brigade or divisional baggage-masters. The commander of the brigade, division, or army corps, as the case may be, must be the sole judge of the expediency of so employing the regimental transport; he would, however, be advised on this point by his principal Commissariat officer. Were the transport to be only attached, instead of belonging, to battalions, it appears to me that, after a protracted halt and other employments, it would soon cease to have the character of

regimental transport at all. That the regimental transport system is a good one may, I think, be taken for granted, from its prevalence in the armies of Europe, and the desire on the part of the Government of India which, I have most excellent reasons for stating, has recently become manifest, to develop the system in the regiments there serving, both European and native.

Departmental transport includes all transport, other than regimental, that forms part of the establishment of the brigade, division, or army corps in the field, and that marches, encamps, and works in connection with the unit to which it belongs.

That portion of the Army Service Corps which belongs to the commissariat and transport department is, by the latest regulations, organized in 16 companies on the peace establishment; each company contains a *personnel* both for transport duties and duties of supply, the necessary number for the former duty being on its mounted establishment; thus the distinction between *transport* companies and *supply* companies, formerly existing, has been abolished, and in future all will receive a sufficient training in transport duties whatever their ordinary employment may be. This, I am informed on the best authority, will apply to officers as well as to the non-commissioned officers and men. Each company has a sufficient cadre to admit of its division into two parts, each part by augmentation to become a complete company, so that on mobilization 32 companies in all can be produced, each subdivided into four sections. The departmental transport of an army corps absorbs eight companies; three to supply its divisions with their first line, one company for each division appropriated by sections, thus,—each of the two brigades absorbs a section of 11 wagons (field forges included) for its staff baggage, butchery implements, and one day's rations and corn for the brigade; one section is allotted to the divisional staff, military police, commissariat and transport detachment, &c., with one day's provisions and corn for the divisional troops and details (cavalry regiment, artillery, rifle battalion, &c.); the remaining section furnishes transport for the divisional bearer-company. In its first line, the army-corps staff and all details not belonging to divisions (cavalry brigade, corps artillery, corps engineers, &c.) require one entire company, including the carriage of the one day's rations and corn, so that these troops may be on an equal footing with the divisions as regards provisions. Thus four out of the eight companies are required for the first line of transport.

The second line, like the first, is distributed separately, viz., that required for each division, and that for the army-corps details not belonging to divisions; it provides transport for the divisional field hospitals (two per division), and for three out of the six movable field hospitals on the corps establishment, it being considered that this number is the greatest that can need removal at any one time: it carries an additional day's rations and corn, both for the divisions and corps details, and furnishes transport for the field bakery and butchery column as well as for the ordnance store department of the corps. In this manner three more companies are absorbed; the eighth company is held in reserve for such purposes as circumstances dictate; it could

carry, if necessary, tent equipment for about three-fourths of the army corps; or, a far more probable use in a European campaign, and one to which it is, I understand, intended to apply it when a line of communications is established, it might be withdrawn from the departmental transport of the army corps, and be advantageously employed in connection with the advanced dépôt.

On the war establishment neither the companies nor the sections have a uniform strength; it is wisely determined that, within reasonable limits, the strength of the company or section shall correspond to the work that is required of it, and work together as a whole; any other plan would necessitate the breaking up of companies into fractions working apart from each other, a radical defect in any military organization; the companies range from 182 of all ranks with 83 carriages, to 230 of all ranks, with 127 carriages.

The general principles of organization and method of distribution of the departmental as well as the regimental transport are not dependent upon the particular means by which the actual carrying is performed; a variation in the means may alter the number of animals and their drivers, probably also the number of minor supervisors requisite, and even the sources from which these are obtained, but can hardly, in itself, be a valid reason for altering the framework of a complicated structure.

The usual data upon which calculations as to the length of road occupied on the march by transport of the regimental or departmental description are based—are as follows, viz. :—

Including an interval of 4 yards from the tail-board of one carriage to the horse's head of the succeeding one, each vehicle with two horses abreast may be estimated as occupying a length of 12 yards; with four horses two abreast, 16 yards, and so on, adding 4 yards for every pair of horses abreast; this applies to guns and their wagons nearly enough for all practical purposes. A pack-horse or mule is allowed a minimum of 4 yards in length, the breadth must depend upon the mode of loading, but it could hardly be less than 8 or 9 feet, so as to avoid collision. A fair estimate for strings of camels seems to be about 5 yards per camel, including the slightly increased interval at the end of each string. Thus, taking the division as practically the marching unit, its troops, accompanied only by such portions of its transport as must be at hand for an action, including half its reserve ammunition column and its bearer company, would occupy 4 miles of road, while the rest of its transport, following as might be found expedient, would occupy $2\frac{1}{4}$ miles more, making the whole about $6\frac{1}{4}$ miles. This includes the unavoidable lengthening out of the column during the march, estimated at one-third added to its original length.

The length of road occupied is very considerably increased when pack-transport has to be substituted for wheeled carriages, and depends so materially on the number of animals that can march abreast upon the road, that it is useless to attempt to frame an estimate for general application. It is moreover found that both pack animals and human carriers open out very much on the march, and are much more difficult to confine within anything like reasonable limits as to road space, than are wheeled vehicles.

I must now pass to the third category, or what is termed the *General transport of the army*.

The regulations for the organization of the line of communications of an army in the field divide, for purposes of command and administration, the area existing between the rear of the fighting force and the base of operations into three sections, viz: the base itself; the road, or roads; the advanced dépôt; each under a commandant aided by a staff representing all the departments of the army whose functions connect them with these sections respectively. Over the whole of this system is placed a general officer with the designation of Inspector-General of the line of communications, whose authority is paramount over all troops and others either employed in or passing through this area, over all the military departments working therein each according to its functions, and who is responsible for every transaction connected with the service of the army in front which takes place between the base and the advanced dépôt, both inclusive. The general transport of the army is the transport, whether of the regular military type, hired, requisitioned, or purchased, which is brought into military use within this area; not, however, including the railway service, the control of which, under the direct authority of the Inspector-General of the line of communications and unconnected with all other transport, is specially provided for by the same code of regulations. It is this general transport which, either in the absence of railways or as supplementary to them, pushes forward supplies to the advanced dépôt within tangible reach of the departmental transport of the army; and it is this transport, almost always composed of heterogeneous elements, brought together often from different parts of the world and with a *personnel* speaking various languages, that commonly presents the greatest difficulty in organizing for the effective service of the line.

When our transport companies have been divided each into two, and augmented to the war strength, we shall have done our utmost in the direction of expanding our existing organization, and it is highly improbable that, in a large undertaking, any important fraction of the general transport of the army could be of the strictly military type. New organizations become a necessity and the material obtainable must be utilized. Vehicles, harness, workshops, and other appliances have to be provided on a large scale, as also dépôts both for spare animals and for the reception of those sick or disabled.

The scenes of our military undertakings vary so endlessly, and the conditions differ so materially that no predetermined type of organization for this description of transport could possibly be applicable to all cases; nor does it often happen that the experiences of one operation throw very much light on the organization requisite for others. Nevertheless certain general deductions may be drawn from successive experiences, so that we may at least be forewarned as to the general requirements of a transport service of this extemporised character, and of the difficulties we may expect to meet with in our path; but it surely is unreasonable to expect to get rid altogether of the defects and weaknesses inherent in

every hasty construction. One of the first points to be determined must necessarily be the system upon which it is intended to work the transport, that is, whether the wagons or animals are to be worked by stages, returning to their own stations after performing a stage; or whether convoys are to be carried through several marches, only returning after an interval perhaps of many days. The experiences of all our recent expeditions are in favour of the stage system whenever it can be adopted. The transport was so worked in the Abyssinian expedition, in Ashantee, and is now being so worked in our operations against Afghanistan. An example from one of the columns will serve to illustrate the case.

Brigadier-General Phayre, the Inspector-General in charge of the line of communications of the Quetta Army, extending from Sukkur to Dadur, a distance of 164 miles, received orders towards the end of January in the present year to make arrangements for conveying six months' supply for 30,000 men to Dadur for Quetta by the 1st May, the total weight being estimated at 360,000 maunds, or 13,224 tons.

For the section of road between Sukkur and Jacobabad, 51 miles, were available 2,580 bullock-carts with two bullocks each, the cart carrying a load of 10 maunds, or $7\frac{1}{4}$ cwt.; these were equally distributed to work on four stages, the stations being at the base end of each stage, viz., Sukkur, Meygrani, Shikarpore, and Hamayin, the average distance apart being 13 miles—this gave 645 carts per stage, 10 per stage being considered as spare; half the carts were to go forward each day and return empty the next, so that it was estimated 95,000 maunds per month would be carried. There appears to have been no provision for a day of rest beyond that possible by the use of the 20 spare bullocks; this was probably due to the fact that the stages were of moderate length, and that the return journey was performed empty, probably also steps were being taken to increase the number of bullocks first available. Between Jacobabad and Dadur, 113 miles, the work was to be performed by pack-transport, for which camels were at once made available, in number about three-fourths of that required to keep pace with the operations on the other section of road, and steps were taken to provide the rest. The 7,750 available cameles were allotted to seven stages; there were, however, only six stations, the second stage being a double one, viz., Jacobabad, Nehal ka Goti (double), Barshori, Kassim ka Joke, Bagh, and Haji ka Shahr; 1,000 working animals and 50 spare were allotted to each stage, leaving 400 as a reserve at Jacobabad to meet emergencies. Thus, at 5 maunds, or 411 lbs. per camel, it was estimated that even at the commencement of the work 75,000 maunds per month would be delivered.

With reference to the system prescribed by the regulations for the organization of the line of communications, I am able to state from reliable sources of information placed at my disposal by the kindness and through the instrumentality of Colonel C. B. Brackenbury, who was to have lectured on this occasion, that its application, in a form modified so as to meet the requirements of the case, on the Sukkur-Quetta-Candahar line of operations in Afghanistan has been attended with marked success, and that some progress had been made in apply-

ing it also to the Kurum line. It is evident also that the Government of India fully concurs in the principle of these regulations, and is seeking to develop the system for future undertakings. Taking the Khyber line as an illustration under existing circumstances, although the system has not actually been put into practice on that line, Peshawur is the base, the officer there commanding might become the base commandant in addition to his district command, a road commandant to be appointed from the second division, and the commander of that division, whose functions would extend to Jellalabad, 88 miles from Peshawur, to become the Inspector-General of the line of communications. Jellalabad to be regarded as the advanced depôt until such time as the first division should advance beyond Gundamak, whereupon this latter place would in its turn become the advanced depôt. This sketch is also derived from the source of information to which I have just alluded. I am unable to give any similar examples from the operations against Zululand, the systematic organization of the line of communications apparently having been too recently undertaken to furnish any reliable lessons at present. The mode of transport in this latter undertaking is peculiar and cumbersome to the last degree. Sixteen oxen draw a long and heavy wagon, the load of which ought not, so far as I can gather, to exceed 30 cwt. or thereabouts, for that portion at least which actually accompanies the troops, if they are to make even average marches with success; as both the capacity and strength of these wagons very considerably exceeds this, the temptation to give them their full load is great, and many evils are spoken of in consequence. Captain MacGregor, staff officer to colonel Pearson during the isolation of the column in Ekowe, writing in February, says, the curse of South African warfare is the transport; he speaks of endeavours made at Ekowe to use their bullocks as pack animals, 16 of which would carry what he considered a proper wagon-load to accompany troops under such circumstances. These attempts appear to have met with a partial success, the want of pack-equipment being the main obstacle; the chief advantage sought to be obtained was that the march of the troops need not then be confined to the beaten tracks, and thus that the enemy might not know with any certainty, as he does at present, the precise spot at which to attack them on the march. There are proverbially two sides to every question, and before accepting this as a solution of the difficulty, we ought to inquire what provision is to be made in substitution for the shelter the wagons afford when no tents accompany the force, and for the defensive enclosure both for men and animals that is so readily obtained by means of a well constructed laager; also, whether the largely increased number of drivers this would necessitate could be obtained, and could be depended on to stay with the troops when the enemy was at hand.

To return, however, to the subject of the organization of units of transport. In the short time at my disposal, I do not purpose troubling you with full details of organizations which have been adopted on various occasions. The historical accounts of our expeditions contain, in most instances, though not always in a concise

form, information from which to derive a sufficiency of such details. From these recorded experiences, coupled with the best opinions I am able to gather from intercourse with officers connected with this service, a few data may doubtless be safely derived for general guidance, and I should only be too glad, after the lecture, to correct my assumptions on further light being brought to bear on the subject. First, in the case of wheeled transport. Every driver, whether in the regular or in an extemporized organization, can, both on the road and in camp, take charge of a minimum of one pair and a maximum of two pair of horses or mules, the maximum only for emergencies of short duration. Draught bullocks do not require so much attendance, as we find at the Cape two men in charge of the 16 bullocks belonging to the wagon. A supervisor on the first step of the ladder can look after from five to ten wagons or carts, according to the number of men and animals belonging to them, and the extent to which the necessities of the case demand a strict conformity to military rules, and other circumstances; thus, a sergeant or a corporal can supervise five 4-horse wagons of the strictly military type, while a supervisor has been found sufficient for every ten 2-horse carts with civilian drivers, as in the organization for the Bengal famine relief operations in 1874. And we find that a petty non-commissioned officer to about every seven mixed vehicles, mostly 2-horse wagons, is considered sufficient in the German organization of their wagon-park columns of hired or requisitioned transport; our own transport officers appear to think that an efficient non-commissioned officer could supervise ten such vehicles. Again, a captain, a subaltern, and a sergeant-major are considered sufficient for the German unit of irregular transport, such as I have just referred to, consisting of 82 vehicles and about 200 horses; this agrees very nearly with an estimate most kindly furnished to me by the Commissary-General at Head Quarters, viz., that 1,000 animals, in companies of 250 each, would require two commissioned and two warrant officers (conductors) per company, a field officer in charge of the whole, with an adjutant, quartermaster, and veterinary surgeon, and that to render such a unit thoroughly efficient for campaigning, the following establishment should be provided for each company; first with reference to pack-transport, viz. :—

One company sergeant-major as pay sergeant, one trumpeter, and eight riding-horses or mules for officers and sergeants.

	Sergeants.	Corporals and Second Corporals.	Privates or Muleteers, &c.
For transport duties	4	8	125
Saddlers and harness makers	1	2	..
Farriers and shoeing smiths.....	1	2	2
Bâtmen, and for various duties	15
Total..	6	12	142

It would no doubt be prudent that the organization should, in the first instance, provide for one muleteer to every two mules, as it would probably be found the number of muleteers would soon be diminished by casualties, while the number of animals must be maintained from the reserves by every effort, otherwise the work allotted to the company could not be performed.

For a company of wheeled transport, including vehicles of all descriptions, the strength should also be determined by the number of animals rather than by the number or description of vehicles, as the carrying power must necessarily be fairly proportionate to the draught, the effective load for such transport on fair roads probably averaging about 6 cwt. per horse or mule. Taking, therefore, the same strength of company, viz., 250 animals, the variation from the establishment above suggested would be but slight; thus, a wheeler-sergeant and two wheeler-corporals must be added, and the farriers and smiths must understand carriage-work as well as shoeing.

For the supervision of the artificers, each battalion of four companies, whether of pack or wagon-transport, would require a farrier-major, a wheeler-major, and a saddler-major, and the workshops should be in common for all the companies at one station.

It is a fatal mistake to over-estimate the powers of transport, and thus afford inducements to subordinates to overload it, in order to fulfil the expectations of their superiors. Assuming, therefore, that three-fourths of its strength can be relied upon for actual work every day, a fair and moderate assumption, the data for calculations would be that a company of pack-transport of the foregoing type could carry an effective load of about 13 tons, and a company of draught-transport about 56 tons.

In the Abyssinian expedition, a division of 2,000 pack-mules was in charge of a captain, with a subaltern for each 1,000, but, according to Sir Robert Napier's amended organization, there were in addition a host of minor supervisors, and it must be remembered that the management of the transport in this expedition was based upon habits and customs prevalent in India, whence the major part of it was derived. The work was performed in companies of 150 animals. It may be said that in India there is no military organization of the transport service. Vehicles and animals, accompanied by their accustomed attendants with a proportion of overseers, are obtained by a sort of compulsory requisition, the inhabitants, from immemorial custom, recognizing the right of the ruling power to their use for Government purposes. The *personnel* is controlled in peace by the simple process of dismissing objectionable individuals, and in war they are, of course, camp followers, and amenable to military discipline.

Under ordinary circumstances one attendant has been considered sufficient for every three pack-mules or horses, as in China in 1860, in Abyssinia in 1868, and in the famine relief operations in Bengal in 1874. In New Zealand, however, in 1861, one attendant seems to have been allotted to every two animals, a good proportion to commence with.

In coolie organizations, such as we have resorted to in China, in

Ashantee, and in the Duffla and Looshai expeditions, a supervisor for every 25 carriers is sufficient, four such sections making a company of 100, which may be commanded by a selected non-commissioned officer. The combination of companies into larger units must, I think, greatly depend upon the conditions under which they are to work.

In any organization, however, whatever its character, required to work along an extended length of road, there must be arrangements to provide for a strict supervision, exercised by inspectors of superior rank allotted to definite sections of road, and constantly on the move thereon, so that they may actually witness the working of every part of their charge at frequent and uncertain periods. Over the whole must be a director, aided by one or more assistants. Even the functions of the director may require subdivision in very extensive undertakings, as was the case in Abyssinia on the division of the transport for working purposes into highland and lowland trains, a sub-director being appointed for the highland train, to receive orders direct from the staff at army headquarters.

In working transport on the stage system there are several obvious advantages; thus, at least each alternate day every man, animal, and article of equipment comes under the eye of the officer in charge at the station to which it belongs, and thus can be more easily kept in a state of efficiency. The unremunerative weights are less, as only a very small portion of the kits of the drivers and others need be taken with them, and the responsibility for the condition of the component parts of the system, as well as for the work actually done on each stage, is easily fixed.

When through two or more contiguous stages vehicles of nearly the same type are used, so that the mode of attaching the draught animals does not materially differ, the vehicles themselves may advantageously be sent through that part of the line, instead of being unloaded at each stage, the drivers with the animals and their harness returning to their station with the empty vehicles performing the homeward journey; it is only on the first starting such a plan that there will be any delay in their return.

Whether or not it may be advisable to make arrangements by which each convoy should be able to return to its station the same night, must, I think, depend upon the particular circumstances of each case. This might, of course, be effected either by increasing the number of stations and making the day's progress of the stores cover two stages, or by causing intermediate stations to send half their carriages, &c., forwards laden, and half backwards unladen, meeting those of the adjacent stations midway. The advantages of returning home each night are considerable; the average daily stages, when the transport returns the next day unladen, can hardly exceed 20 miles, probably 18 would be a safer estimate; whereas by equalizing each day's work, half being performed laden and half unladen, probably 11 to 12 miles each way might be accomplished with the same wear upon the animals; there would thus be a gain in the day's progress, in addition to the immense advantage of every man and animal sleeping each night at his own station. On the other hand, this plan has the serious disad-

vantage, either of largely increasing the number of stations, and entailing the inconveniences of numerous separate establishments, or of involving complex arrangements for meeting and transferring stores midway; and it is probably on account of these drawbacks that we find the single stage system more often adopted.

On first commencing to prepare my lecture, it was my intention to explain the leading features of the transport systems adopted in some of the continental armies; I have been compelled to abandon this branch of the subject, feeling that I have already made large demands upon the patience of my hearers. I consider, moreover, that however interesting, and in some respects also instructive, may be the arrangements of our neighbours, there is a strict limit to the points therein from which we can derive lessons practically useful as guides in our own case; as with every other description of machine, so with an army, each limb must be so constructed as to work in unison with the other limbs for the efficient service of the body, therefore unless we mean to remodel the original framework, it is of little use to borrow a ready-made part of some other machine, in the hope that by good luck it may fit into the place where we perceive there is a deficiency in our own.

There is still one question, and it is a very old one, that must not remain altogether unnoticed, although the mere mention of it opens a wide field for discussion; it is, whether it is desirable to combine transport duties with those of supply, and hold one chief responsible for both; or whether transport should be controlled by a separate chief, and be dealt out to the supply department on its requisition, as to other branches of the army.

The report of one of our ablest Committees, Lord Strathnairn's, which bears date March 5th, 1867, contains the following opinions, viz.:—"The Committee have agreed that army transport should be organized as one service, and, as transport is so intimately connected with and is of such vital importance to, supply, it must necessarily be under the direction of the officer at the head of the administrative staff of the army who is responsible for the supply. "It would, in fact, be impossible to enforce such responsibility without giving absolute control over the means by which the supplies are collected and conveyed."

"The Committee consider also, that in bringing the supply department under one control with the transport, they have ensured both large reductions in the quantity of stores and economy of the transport, which separate and independent supply departments would otherwise compete for, to the general detriment of the Service."

I submit that the head of the administrative staff, contemplated by the Committee when these views were expressed, is, in substance, the chief of the commissariat department as now constituted, for they did not recommend that the charge of material of war should be included in his responsibilities. The functions of the late control department were made to embrace this charge in consequence of the report of a later Committee, and the mistake has been rectified by the establishment of a separate ordnance store department.

The advocates for the establishment of a separate department for transport, independent of the commissariat, urge two principal objections to their combination: first, that in peace time by far the greater number of officers of the department are employed in supply duties, and receive no training in those relating to transport, and thus, when an urgent demand for trained transport officers arises, they are not forthcoming, and their duties have to be performed by others unused to the work. Secondly, that the difficulties in expanding the transport service are greatly augmented by the unwillingness of line officers to serve under officers in the junior ranks of the commissariat and transport department, and thus the most suitable are not always obtained.

Supposing a separate department for transport to be established, would it be of such a magnitude as to offer greater facilities for the training during peace of more numerous officers and non-commissioned officers than are at present trained? Would not the increased expenses of a separate department, even on the scale of our present transport service, inevitably invite, in our economical fits, the application of the pruning knife to that part of our military establishments which would least show the lopping to the public eye, until practically there would be but a shadow left? Whereas by connecting it with a large and influential branch of our administrative machinery which has not only the power, but doubtless also a direct inducement, so to employ the transport in connection with its own transactions as to justify the expenses of its maintenance, such tendencies to retrenchment are greatly modified. A separate department at home must be followed by a similar change at all our military stations where local transport is now employed under the commissariat; are we prepared to set up such detached establishments under separate transport officers? Almost all our colonial wars are preceded by a period of uncertainty as to the magnitude which the undertaking is likely to assume, during which existing institutions are gradually expanded according to the exigencies that arise; thus, were we to adopt the principle of separation at home, while in our colonies the transport remained under the commissariat, would not the same embarrassment that took place in the New Zealand war occur over again, namely, that on the arrival from home of part of our transport (then a separate service) it could not be utilized in connection with the existing local organization under the commissariat which had grown up out of the peace establishment, and separate employment had to be found for it.

Unless the separated transport corps had something approaching to a combatant status, would expansion be an easier process than it is now? Would combatant officers be more willing to serve under those of its subordinate grades than they now are under those of the commissariat? and, when our transport had such a status, was it so great a success as to tempt us to repeat the experiment? Had it not rather become something between artillery and light cavalry, officered by those who for the most part never were, and never aimed at becoming, skilled in the duties appertaining to a carrying organization? Again, in every petty transaction involving both supply and

transport, when the services are distinct, endless difficulties arise with reference to the responsibility for the stores during transit, and their due delivery at their destination, and when separate conductors are sent in charge of the stores, they can but very imperfectly perform their duties without any authority over the proceedings of the transport party.

A discussion is to follow; I imagine, therefore, that one who presumes to lecture should clearly indicate his own opinion on so important a point relating to his subject; if that has not been already done, I must say, with the greatest respect for the opposite views held by many officers of far wider experience, that my own answers to the questions suggested are unfavourable to the principle of separation. The approaching reorganization of the Commissariat and Transport Department, whereby it will be given a character far more strictly military than it has ever hitherto had, with officers who have passed years in the combatant ranks, will doubtless confirm its thorough recognition as a cordial fellow-worker for the common weal by all other branches of the army, and remove many of the difficulties in the way of an expansion of its transport service. Until this new scheme bears fruit it is a point worth considering, whether, when large numbers of combatant officers are necessarily employed in transport duties in campaigning, it would not be possible to meet their known objections and prejudices, by such a distribution along the line of communications as would ensure one of their own number being in command of the transport at any station where many are employed, receiving his orders from the superior commissariat officer in charge of any given district; his strict co-operation with the supply officer, when there is one, might doubtless be confidently relied on, as each would have the same superior. Moreover, the royal warrant under which the department is constituted clearly implies that during active service combatant officers with special ability and aptitude for the organization and management of transport, may be temporarily appointed to any grade therein; thus, in addition to the talent contained in the department itself, it practically has, on emergencies, the command of that in other branches of the service also, without the slightest infringement of the principle that the chief of the commissariat with an army or an army corps, is also chief of its transport.

There are several special branches of the subject of military transport to some of which I have but casually alluded, and others have not been mentioned at all. Among these are the wide and highly important subject of the military use of railways, the transport of ammunition, the transport of heavy siege trains, the transport of sick and wounded in war, the order of march and the protection of convoys, the methods of encamping transport, and the recruiting and training of soldiers of the transport service. Some of these have already been the subject of consideration in this Institution, and, as regards such as have not, we may perhaps venture to hope that, as opportunity offers, the Council may be pleased, with the assistance of those who have made these special branches their study, to afford us the opportunity for having them fully discussed.

Colonel ALCOCK : In the presence of so many distinguished Officers, I should have thought it presumption on my part to be the first to address this meeting ; but as no one has risen for that purpose, I may, perhaps, be allowed to say a few words. I am sure we shall agree that this excellent lecture has added much to the scientific and practical knowledge of the members of our Institution. At the commencement the lecturer referred to the difference between our system and those of the Continent. It is evident that our military system must be one entirely peculiar to ourselves. We have a problem of our own, and cannot conform entirely to the characteristics of Continental nations, inasmuch as they act upon entirely different principles. The railways are the essential elements of their strategy ; but our men are raised in a different manner, are employed in every part of the world, in every climate, and in every description of war, and are, with their employment and duties, generally beyond the reach of railways. I remember the description of a Pioneer railway¹ once given in this Institution, and we then saw the extraordinary advantage that might be derived from being enabled to push a railway into an enemy's country with great rapidity. The lecturer has referred to the Zulu War ; and I may mention that foreigners are regarding our operations simply with a view to ultimate results, while we necessarily look to the very important and anxious details of what is now going on. The Germans say that Africa can never be civilized until the English have brought the Kaffir races under control. The French seem to have something of the same opinion ; for Victor Hugo, only the other day, said that Europe would never be satisfied with Africa in a state of paralysis now communism is the troubling spirit of the age, and he said that the remedy for that social danger would be found in emigration to Africa, by which proletarians would be changed into landed proprietors, I suppose, in Central Africa. A German author, Dr. Fabri, has also referred to the same subject with respect to colonization and colonies, including Central Africa. He proves, by statistics, an increasing population in Germany beyond the means of support, which is an increase of the proletariat, the social consequences of which would be very critical. Now the well-being of a country depends upon the power of expansion ; but as our colonies are open to the emigrants of all countries, it follows that our armies have fought and are fighting in the civilizing service of the world. I mention this to show that foreigners take an interest in the question, and imagine that there is a wider and a deeper meaning in this war than we ourselves supposed. I have been reminded that I must not introduce any new subject, and I confine myself to what I believe to be of some interest, namely, the fact that, with the consequences of this war there is associated in the minds of different people, in one way or another, the future condition of Central as well as of Southern Africa.

General Sir ARTHUR CUNYNGHAME : As the subject of transport in Zululand and South Africa has been alluded to by the lecturer, I think it my duty, having had some experience in it, to say a few words to this meeting. I consider that the system of wagon transport in South Africa is unduly underrated. We must remember that the wagon with sixteen bullocks in South Africa has been an institution of that country before the time at which we took possession of it, and the facility with which large amounts of goods and provisions could be carried in South Africa by this means is astonishing. It would surprise many people were I to tell them of the distances or the undertakings which are carried out by this transport in South Africa. Men are unceasingly for years engaged in this employment, sleeping under their wagons, which indeed make exceedingly good coverings, and they thus convey goods from Cape Town 900 miles into the interior, and indeed very much further, towards the Zambesi. If this description of transport were condemned, it would be necessary to send other wagons from this country ; and if transport by oxen were condemned, it must be supplemented by a larger number of mules, imported from South America or other countries at an immense cost. Wars in South Africa are very sudden ; considerable reliance must therefore be placed upon the transport to be found in the country. It has been said that sixteen bullocks, if they were made to carry loads upon their backs, would conjointly carry 32 cwt., and that that quantity would be equal to the load carried in a wagon.

¹ Haddan's Pioneer Railway.

Here, I consider, a great mistake is made; instead of only a ton and a half being a load for a wagon, I know that these wagons will carry, under particular circumstances, as much as five tons: and therefore the advantage of the wagon in that respect is very great. I may add, however, that it is not a good plan to trust entirely for the transport of these large wagons in South Africa. When I had the honour of commanding there, I did my best to supplement it by a system of Scotch carts, with two oxen; these were exceedingly useful. When bad roads had to be traversed, I caused brakes to be attached to these carts, which had a very good effect in retarding their progress down hill. These small carts were built to carry at least 3 cwt., and thus substituting six or eight Scotch carts for one wagon, if one broke down, it was not difficult to transfer the load to the others. I believe Lord Chelmsford has done his best to increase the number of Scotch carts. The advantage is undoubted; they readily run down small hills and declivities; and the wheels can even be taken off and the carts carried for a short distance, where it would be impossible to move the large wagons across bad spruits or streams. I took some pains, also, to have some of the mules trained to carry pack-saddles; but it must be remembered that in South Africa, at certain seasons of the year, it is exceedingly difficult to feed bullocks at all. I allude especially to the months of June, July, and August. Then, if an army must move, it adds enormously not only to the expense but also to the required supplies, for the bullocks, when there is grass, feed themselves, but for the mules a considerable quantity of grain must be carried. Mr. Chairman, looking upon my former position in South Africa, I thought it my duty to make these few observations upon the subject of transport now before this meeting.

Captain GEDDES: There is one point of detail in this matter which we shall all have to consider sooner or later, viz., the *personal* carriage of ammunition and intrenching tools. These should always be with the men. The general transport does not deal with this point. In fact, when intrenching tools are wanted, they are very often not to the fore. My suggestion is simply this: let each section of a company (say 20 or 25 men) carry their intrenching tools in a hand-cart; such a cart might be utilized to carry spare ammunition, for instance, a box of 600 rounds, giving some 30 rounds per man; even three or more days' provisions might be added, and still the cart kept well within the capability of two men to draw. It may sound curious to suggest such an addition as four hand-carts to the *matériel* of a company, but I believe the time is coming (especially when repeating arms will be used) that these hand-carts must form part and parcel of the company, be drilled with them, and, in fact, be always on the spot.¹

Captain APPLIN, late Transport Corps: I would venture to say a few words bearing on this most important subject; having had great experience in the transport service, I feel that my remarks may not be out of place from a practical point of view. The great question with regard to transport is its organization, and that means expense. It would be too painful, perhaps, to go back to the Crimean War, where we saw nothing but disorganization and failure; after that sad experience we formed, from the remnants of the Land Transport Corps, the "Military Train," under Colonel McMurdo. That was an exceedingly well-organized corps, and they thoroughly did their work, as was shown in the several imaginary campaigns on Woolmer Common. The corps was well officered and commanded, the drivers thoroughly trained and efficient; and although the Military Train were few in number, not more than ten battalions of 400 men in each, the whole proved a great success. There was only one thing against it, viz., the very great expense. If you have an organized transport of that description, capable of taking the field (I am speaking of horses and wagons), you must have an expensive transport. With regard to the use of railways, as shown by the lecturer, that is not a matter of transport, it is simply conveying supplies from the base of operations to the *dépôt*, which would of course be taken advantage of so soon as we had firm hold and could establish ourselves; but what we have to get at is, conveying supplies from the *dépôt* to the army in front. I would suggest a plan by which the difficulties we are now labouring under in

¹ Such a cart has been invented by Colonel T. Martin, late 4th King's Own, and may be seen in the Museum of the Institution.—ED.

South Africa from the want of transport could be easily and inexpensively overcome. We have always suffered and our advance been retarded from this most important arm of the service. The transport I allude to is the Chinese Coolie Corps, the most perfect, inexpensive transport in the world. During the campaign in China, the Coolie Corps saved, I might almost say, the British Army; for had it not been for those splendid fellows, we could never have arrived in the time we did at the gates of Peking. The canal transport was of some service, but always open to attack and consequent destruction. Another great advantage of the Chinese coolies is, that they can defend themselves, and behind intrenchments they are very formidable enemies to deal with. In the China campaign, 1858-59, we sent out one battalion of the Military Train, consisting of about 400 men; this force, on arriving at Hong Kong, was broken up into sections, and scattered in all directions to take charge of effete men of different castes sent from all parts of India; to these were added Manilla men; and a more incongruous mass of human wretchedness cannot be conceived. We brought ponies from Manilla, ponies from Japan (the latter so vicious that no one could go near them), bullocks from China, bullocks from India, too sacred to be touched; before landing at Petang more than 2,000 animals died. Not to enter into further details, too painful to bear light, suffice it to say, that the whole thing broke down, and we had to fall back upon the resources of the country, which fortunately were equal to the emergency. I have no doubt that with a very little organization a Coolie Transport Corps could be formed, which, for economy and efficiency, would not be surpassed. The Chinese are a most sober, tractable race, and under European Officers will fight to the last.

Admiral SELWYN: Although a naval Officer, I venture to rise to communicate to the meeting one item of progress which has been made in this question. We are all aware that a very large proportion of the weight of every article of food arises from water. I am able to put before you the fact that you can diminish the weight of all food necessary to be carried for an army, its horses, and men, down to one-sixth of what is at present carried, and that with perfect facility. It is being done; and where such food has been sent out to the army at the Cape it has received the high commendation of General Officers on the spot. The result of this will be that instead of 52 rations weighing 160 lbs., we shall bring them down to 27 lbs., and this will solve a very large portion of the difficulty. I should like to correct a mistake made the other night in the House of Commons where it was stated that the erbswurst was simply pea soup. The erbswurst is something more than that: it is a carefully prepared chemical food in which every element necessary to support human life is properly proportioned, and its keeping qualities are absolute for any number of years. You may, therefore, dismiss from your minds a great many of the necessities which have been spoken of if you will consent to examine carefully the progress which can be made. Then there is another direction in which economy may be gained, and it may be seen in the difference in the wagons used throughout America and Canada in their power of transport compared to their weight, and those used in most other countries. This arises largely from comprehending the true use of steel and the true use of hickory. I was in such a wagon drawn by two horses at night, and we came to the mouth of a canyon in the Rocky Mountains. It was late at night, and I suppose we were blocked by a rock about the size and height of this table; but the driver made his horses get up on the rock and coolly dragged the wagon over it. I got out to see the condition of the wheels, and I found that they were just as good as before: they had not sustained any injury. There was not a bolt or anything else broken. I am bound to say that the wagons are built rather loosely. They approach much more nearly to the great Cape wagons, in which hide is largely used instead of other fastenings. If you desire to subject such a structure as a wagon to undue strains of that kind, you must provide for the free play of its parts. That I think has been too much ignored in our present wagon construction, and we may derive some information in that respect from American and African practice.

Sir WILLIAM CODRINGTON: The question of transport, no doubt, is one of the most important the army can consider, and we certainly in the Crimea had difficulties connected with it. The circumstances of the expedition to the Crimea were such, in Lord Raglan's opinion, as to render a limitation of baggage necessary, and not a

single baggage animal was with the divisions of the army. With the 27,000 men and officers, we took nothing but 150 mules attached to each division for its small arm ammunition. That shows that there was no nucleus of transport whatever at that moment, and subsequently we had to get on as well as we could under the difficulties of the passage from Balaclava, which was through a sea of mud. So little does England keep up an establishment of this kind, which is essential to the well-being of an army even in the smallest expedition, that I remember it was necessary, when we had to consider as to a future campaign to take 300 bayonets from each division of the army of the Crimea in order that the division should be made at all movable. That shows how essential it is that the Government of this country, if it really wants to keep troops efficient for the Cape, or anywhere else, should keep up the nucleus of an establishment in real efficiency. You may get a certain quantity of transport, as Sir Arthur Cunynghame has mentioned, from the native inhabitants, and it is essential to make use of it; but in order to provide for your ammunition, and a certain number of days' supply, the nucleus of a military transport should be maintained. A Land Transport Corps and Military Train was attempted to be established here, but as a matter of economy it was cut down, I may say ruthlessly; that is the real ground of our not being able at once to move. We see it in almost every expedition that has taken place. Look at the difficulties at this moment in Zululand, where the advance has to be put off unfortunately day after day, possibly from the want of that very nucleus which could be expanded when once you have a fixed military establishment; but you cannot extend it if you have merely a few men and no means. Therefore, it is really a question of the Government and money and nothing else. Whether the commissariat is to have charge of its own transport, or whether the transport is to be a separate establishment, may be a difficult question to decide; but transport arrangements ought to be considered, being vital to the efficiency of an army if that army is to be movable.

General McMurDO: My name was mentioned just now in connection with the services of the Military Train, and I think it only right to say the Military Train, as it was organized by me after the Crimean War, was not according to principles that I approved of. The Military Train followed the establishment of the Land Transport Corps, but not upon the principles of that corps. I found new principles cut out and dried for me upon my reaching this country from the Crimea several months after the army had returned home. In saying this I think I should be only keeping you in the dark if I did not explain how the Land Transport Corps came to be established during the Crimean War. I do not wish to urge here my own opinions of the principles on which the transport of an army should be conducted, it is necessary to describe the Land Transport Corps in order to show how it was that I could not approve of, and that I never considered the Military Train a really working corps. It was in that first desperate winter of 1854 that I received, when in Dublin, a letter from the late Lord Hardinge, then Commander-in-Chief, saying, "You know what has happened in the Crimea, that the army is hard pushed through the excessive hardships of the climate, the difficulties the commissariat have to encounter, and the entire breakdown of the transport, and I desire you to come over and confer with the Duke of Newcastle upon the steps necessary to restore the transport of the army." I went over immediately; but I did not leave my hotel until I had laid down the principles upon which alone I would act, and those were that the corps I proposed to form should be entirely separate from the Commissariat Department. I was not urging principles of my own, but those of a great and an acknowledged soldier, Sir Charles Napier, who, in the campaign in Seinde, saw the necessity of organized transport; and I assisted him in the formation of what was then called the Seinde Cavalry Baggage Corps on the principle of entire separation from the Commissariat Department. The objects that he had in view were first to prevent over-loading. The second, to maintain due order of movement upon the line of march. The third was, by armed and disciplined drivers, to release the infantry of the line from the duties of baggage and grazing guards. These were his chief points, and in forming the Land Transport Corps of the army in the Crimea I followed those principles, and I believe they would have been successful had the army taken the field. But we were obliged to

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throw the whole strength of that portion of the transport, which was brought to the Crimea, into the siege operations. It was my intention, however, if we had taken the field, that the system of regimental, divisional, and departmental transport should be commonly followed with a reserve available for extraordinary requirements. I quite agree with those who mention the extreme difficulty of the transport question wherever the army happens to operate; my idea at the time I started for the Crimea was to make full use of natives as drivers; but I very soon found that they were utterly useless. Europeans had to take their places, and, as Sir William Codrington has just said, he had to reckon upon the contingency of withdrawing for this purpose so many bayonets from the army. The same difficulty presents itself just now in Zululand where Wood's column is said to be crippled because the native drivers have deserted. The wagons are good, the oxen are there, but large numbers of the drivers, who are a trained class of men, having deserted, operations are at a standstill: therefore, whenever we make war we ought to have a Land Transport Corps as a distinct department. But here I may mention that there was one part of the Land Transport Corps with which we succeeded particularly well, namely, the administrative branch, through the working of which the resources of every country within the theatre of war were drawn upon by means of agents for purchase and accountants; and thus, in addition to the Crimea, depôts were formed at Trebizond and Sinope, Scutari and Antioch, where at the time the peace was signed 27,000 animals were collected, probably sufficient if it had been determined to put the army in the field. The lecturer mentioned the obvious difficulties presented to troops of regular transport, such as the Military Train, being sent out suddenly for service, foreign to their training, as was the case (which he instanced) with a battalion of the Military Train sent to the New Zealand War, where the army was already operating with transport furnished by the Commissariat Department.¹ For where there are commissariat Officers, there should be Officers of the Transport Department also, to take up the threads from the commencement. The transport of ammunition is another most important point. Before the Crimean War there was for the carriage of small arm ammunition what, I think, they called the "Small Arm Ammunition Brigade," consisting of a certain number of trained drivers, horses, and wagons—a complete establishment, in fact, for the transport of the small arm ammunition of the army; and if that brigade had been carried to the Crimea with Lord Raglan's expedition, we should not have heard of over-loaded mules kept moving in circles during every halt of the troops, to prevent them from lying down! But what happened to this small arm ammunition brigade? The artillery wanted horses, drivers, and harness to establish fresh batteries for the field, and so two batteries were formed out of the small arm ammunition brigade. That, I think, was a great mistake. I endeavoured to establish a system for the transport of small arm ammunition, but more powerful influence than mine prevailed, so that the transport of ammunition was taken from the Military Train, and given over once more to that branch of the service that had at the commencement of the war broken up that important service, in order to equip their own batteries. The argument I used was this: "Suppose a brigade of infantry in action had to retire to a fresh position, and that the battery supporting it had to retire also. Suppose, also, the casualties among the horses so numerous as to cripple the movement of the battery; would not the commander sacrifice the small arm ammunition wagons rather than his guns?" Naturally, and however much mistaken, that would be his first thought. I consider, indeed, that the recurrence of another great war will show once more (when it may be again too late) that separation of the transport of the reserves of small arm ammunition from the artillery is as necessary as that of general transport from the commissariat.

Mr. HADDAN, C.E.: Though not a military man, I have always understood that mechanical precision was the soul of military organization; but, when an ultra-civilized army, the pink of mechanical perfection, is brought face to face with primitive conditions of transport, then comes the tug of war, for I fail to see how it is to be expected that harmony can exist between the two extremes. It is evident,

¹ But if the Military Train had been formed on the principle of the Land Transport Corps, the result would have been different.

therefore, that some handy means of transport is required, which shall work with mathematical precision in all weathers, and under all circumstances. The model on the table shows how, by using a single rail elevated a few feet above the ground, the physical difficulties of the soil may be conveniently ignored, while the elements are not provoked by interference with their attributes of a long enjoyed free right of way. Compared with a bad road, the advantage, even with animal traction, would be ten to one in favour of the ariel tram, that is to say, on the ascents, while on the falling gradients gravitation would perform the work gratis, and at a velocity sufficient to secure a through average speed superior to any existing form of animal transport. It must not be forgotten that through speed is of little importance, since it only affects the *first* delivery. The tram would be worked on the stage system, the animals being confined to the ascents, made as short as possible consistent with commanding the descents. Since in a campaign it is *le premier pas qui compte*, the first line should be pushed forward on a rough and ready plan, and worked by animals. To effect this, the construction materials would be carried forward in the following makeshift but efficient manner, so as to do away with return empties, which are the bugbears of transport, especially of single lines. This would be effected, as shown in the model, by the materials and stores being so arranged as to be suspended in pairs astride the rail, in donkey and pannier fashion, the load hanging on light temporary wheels running on the rail, without the intermediary of a vehicle of any sort, the freight, like that of timber lorries, being self-supporting. The wheels are double discs, bolted together in the middle, the bolt having a capstan-head, through which a stick is placed to tighten it for brake purposes. The sheet iron wheels only cost about 2s. 6d. each, so their loss is not an item for consideration, while the store cases will come in handy for many useful purposes, and at worst for firewood. Semi-cylinders are the best form for the cases, a pair being easily transported by rolling and, moreover, useful as pontoons. The cases are to be water-tight, and contain sufficient air-space to enable them to be discharged over the ship's side into the sea. The towing animals would choose their own ground anywhere within 100 feet of the structure; but all unduly high situations, such as river crossings, &c., should be arranged to be traversed by gravitation. This is the principle which I have had the honour to submit to General Clifford, and upon the practical suitability of which to Zululand he has spoken favourably, and requisitioned for 100 miles for use in the field. The whole of the materials being in the market, ten days will suffice for the manufacture and shipment of the railway complete, and about twenty days for its erection, and the rates current are so exaggerated as to pay for the whole in five days.

Mr. G. FLEMING, 2nd Life Guards: This question of transport is one of the most important questions in relation to our army, for no branch requires a greater amount of attention to details. In my experience, the most expensive and troublesome kind of transport is the pack transport, and a great deal of the trouble and expense is due to want of forethought. In the first place, our transport is neglected during peace time, and it is only when war breaks out, that we begin to direct attention to it. What happens? We are obliged to procure animals from all parts of the world, and sometimes natives to attend them, from all parts of the world, and our nucleus of home transport is utterly unable to control such a large mass of transport as is collected on these occasions. Such was the case in China, and also in the Crimea. I think it would be very much to the advantage of the country if we had a school in which Officers as well as men could receive a certain amount of instruction in animal management, for the loss sustained on service is something appalling, and a large proportion of it might be altogether prevented. The amount of destruction caused in China, in a few days, from the use of bad pack-saddles, was something terrible, and this was a matter about which we might have had some foreknowledge. Again, at the last moment, we are obliged to draw upon the army for Officers to manage the transport, and such Officers have generally no knowledge of the management of animals—no knowledge of the loading or working of them—and the consequence is that in a very short time the animals entrusted to their charge break down. I do not think it reflects very much credit upon us as a civilized and military Power to feel that we have no school in which Officers, both of cavalry, artillery, and the line, can be taught some of the rudiments of animal management.

In other countries we have schools attached to the large Government stables, in which Officers receive this knowledge, and I am quite convinced that those countries must largely benefit by the knowledge which those Officers acquire. With regard to the question of food and transport, it is most important that every article to be carried should be reduced to the smallest weight and bulk. We have been trying experiments with the biscuits now before you, and they seem to show that animals can be kept for a number of days on at least one-third of the weight of ordinary forage. These are matters of detail which deserve the most earnest consideration, and I am sure I shall be forgiven for directing attention to them. I am quite convinced that upon the transport of the army depends the usefulness of the army, and I think our neglected transport has caused the country a very heavy loss indeed, and very great inconvenience.

Commissary POWELL, War Office: The question of transport will ever remain a difficult one for our Commanders to deal with. In the first or fighting line of an army the fewer non-combatant mouths and transport animals we have to feed the better; happy, indeed, would be the Commander who could banish them from his lines altogether. A suggestion has recently been made, by the Rev. H. G. Mason, M.A., of Croydon, which, if found practicable, would, I cannot help thinking, be of immense service in this direction; it was to the effect that a hand-barrow with a single wheel, similar to that of a bicycle, running through its centre, could be so arranged as to enable *two* soldiers to carry at least $1\frac{1}{2}$ cwt. in addition to their own arms and kit, and keep up with their regiment while marching, regardless of obstacles which would be insurmountable to our ordinary wheeled transport. The advantage of such a system will, I venture to think, be at once apparent to those who have had practical experience in the transport service. 150 of these *hand-wheels* would carry upwards of 11 tons—a weight more than sufficient for the requirements of a regiment 1,900 strong. The 300 bayonets temporarily withdrawn while the regiment is in motion would be available at any moment by lagging the wheels and leaving them under a baggage guard, or in case of sudden attack they could be formed into a breast-work of no mean importance. From a supply point of view, such a system would be invaluable, rendering the fighting line independent of its advanced depôts for days at a time. To attain the degrees of mobility necessary for armies now-a-days, the soldier must carry less on his person than he has hitherto done. His three days' rations, 100 rounds of ammunition, great coat, small spade and arms, about 30 lbs. in weight, is as much as we ought to tax him with; all other necessities should fall on the regimental means of conveyance, whatever that may be. The question of the separation of transport from the commissariat has occupied the minds of our military administrators for years. After the experience of many campaigns, and on the recommendation of a Royal Commission, the two services were combined in 1870, and have remained so to the present time. The question is too large for me to venture on at this late hour, but I would ask those Officers who advocate the separation of these services whether any one of them would undertake the responsibility of supplying an army in the field without having the control of the transport in his hands?

The CHAIRMAN: We must thank Colonel Clifford Parsons for the very able manner in which he has dealt with this subject. He has compiled his lecture in a very short space of time, and I think the very clear manner in which he has produced his arguments is most creditable to him, able as we all know him to be. I think, in all our considerations of this subject, we should clearly bear in mind the three great divisions that exist in our system of transport. 1st. The line of communication from the base of operations to the advanced magazine. 2nd. The transport from the advanced magazine to the headquarters of divisions. 3rd. The distribution of rations, stores, &c., from the division headquarters to the different brigades and regiments. The transport from the base to the advanced magazine may be by railway, canal, hired transport, or in fact by any means, according to the nature of the country. From the advanced magazine, which should be one day's march from the front, to the division headquarters, must be trained departmental transport, and what is in front of that, the distribution to the regiments, must be regimental transport. If we bear in mind these three divisions, all our arguments and discussions on the subject will be much facilitated. The organization of the unit of

transport with pack animals has been under consideration for a considerable time. It would have been elaborated long ago, had it not been for the death of our much-lamented Colonel Home, who had that subject under his consideration at the time of his death. It is now under consideration again, and I hope, before very long, we shall have the organization of pack transport fully worked out, as well as the transport with wagons. It may also be carried out with elephant and camel transport for India as well. The great points of contention are with regard to the regimental transport, and whether the transport is to be a separate corps altogether, or whether it is to be undertaken by the commissariat department. There are many arguments on either side of the question, in respect to both those subjects. Perhaps, one of the strongest features we have to consider in the organization of the regimental transport is this: if it was to be supplied by the commissariat, the organization of the commissariat in time of peace must necessarily be very large; there should be a great number of Officers and non-commissioned officers prepared beforehand, ready to be attached at once on mobilization of the regiments. If the non-commissioned officers and Officers, as it has been proposed by some, are to be regimental, and the men only commissariat, I think it would form a very awkward kind of organization. If they are to be all commissariat, I think it is very questionable whether the department, when they are endeavouring to bring their own corps up to a war strength, and have great difficulties in expanding it, would be able to part with so many Officers, non-commissioned officers, and men as would be required by the regiments to form their transport; whereas, if it is purely regimental, the regiments will take care of themselves, find their own men, and will require only their horses from the commissariat. With regard to the question respecting the Transport Corps, it must be remembered that the medical and the ordnance departments require transport as well as the commissariat, and it is a question whether it would not be better to have a separate corps, giving the transport to the different departments—commissariat, medical, and ordnance—the portion that is given to each being permanently attached to it during the time that it is required, or whether, considering that the commissariat are most interested in the transport, it would not be better to throw the responsibility of the transport entirely upon them. These are matters which it is difficult to decide, and they must remain for discussion amongst those who advocate the two principles. I now propose a vote of thanks to Colonel Parsons for his excellent lecture on this occasion.

Ebening Meeting.

Monday, May 19, 1879.

ADMIRAL SIR COOPER KEY, K.C.B., Member of Council,
in the Chair.

ON STORM STABILITY AS DISTINGUISHED FROM SMOOTH-WATER STIFFNESS.

By JOHN SCOTT RUSSELL, Esq., F.R.S., &c., &c.

I AM deeply sensible of the high honour you have done me in selecting me to prepare for you a statement and explanation, and practical applications of a portion of hydrodynamical science, of nautical experience, and of naval construction, which has not hitherto been truly completely, or usefully treated either by philosophers or practical men.

The title you have given me for the paper has been most wisely chosen. It shows that experienced sailors know much better than landmen what it is that constitutes a good sea-going, sea-keeping ship. It tells us that what the sailor wants for his ocean-loving home is not the fine-weather yacht, nor the smooth-water floating fortress built by modern landmen, but the sea-going, sea-loving, ship-shape ocean man-of-war, which is always stable, quiet, gentle, easy, and graceful, whether in smooth ocean swell, or in the storm of the hurricane, or on the breakers of the tempest.

Now I am quite willing and ready to fulfil the arduous duty you have given me. I have devoted all my recent leisure to getting at the bottom of all the unsolved questions which it involves; but I am obliged to confess at once that I cannot fulfil the whole of the task set me, in one sitting, in a manner worthy of the subject or worthy of the audience. I have, therefore, at once to beg you will excuse me if at the end of our meeting you find that I have not exhausted this prolific and useful subject, but only opened it up and covered a small part of a very wide investigation.

In this difficult position I think I can be most useful if I first give you an inventory of the subjects to be considered, and of the elements of the questions to be asked and solved, and afterwards I may take up some of these questions and leave the rest till another time.

Inventory.

1. What is a storm?
2. What is smooth water?
3. What is stiffness?
4. What is stability?
5. How is a storm created from smooth water?
6. How is smooth water got out of a storm?
7. How is a stable ship made?
8. How is a stiff ship made.

The answers to these questions open up quite another series of questions which inevitably follow:—

9. What is the nature of sea waves?
10. What is the nature of breakers?
11. What is the nature of a ground swell?
12. What are storm waves?

Afterwards follow these questions:—

13. How is a crank ship to be made stable?
14. How is a stiff uneasy ship to be made easy and stable?
15. How is a ship to be made stable in storm?
16. " " easy in tempest?
17. " " gentle on swell?
18. " " stiff under canvas?
19. " " steady on waves?

And at the same time—

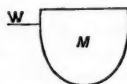
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| 20. Crankness, | } to be avoided. |
| 21. Rolling, | |
| 22. Capsizing, | |

PART I.

Now I will start at once with the fulfilment of my duty by taking up each of these questions.

I think that for your purpose it will be most convenient that I should begin at the end. I therefore at once take two forms of ship, both equally bad and of opposite badness, and ask you to choose the better from the worse as our first step in progress. (See Figs. 1, 2, 3.)

FIG. 2.



The Rock.

FIG. 1.



The Raft.

FIG. 3.



The Ship.

The ship-shape is easy, lively, stable, and gentle.

The raft is lively and stable in smooth water and fine weather only.

The rock is steady and stable in all weather, never easy, gentle, nor lively, always quarrelling with the waves until beaten in or broken up.

Let us now study the behaviour of each of these ships on the waves, and the causes of that behaviour.

1. The shoulders of the raft are too broad and too strong. They are so powerful and so large, that smooth-water waves and small seas have not size nor power to move them fast or far, and therefore move them slow and gently.

But these broad shoulders are just the levers which the storm waves use to jerk the raft up and down with quick, violent motion, and they furnish the powerful lever by which the destroying waves called wreckers or breakers get hold of the ship, mount upon the deck, and overwhelm it.

Thus the shoulders which give smooth-water stability, give violent motions and dangerous positions under the attacks of storm waves.

2. The rock, on the contrary, is stiff and upright in smooth water, and carries great press of sail with small inclination. But it stands too upright and too stable when among the storm waves, for the wave-motions are both horizontal as well as vertical, and the violent horizontal motions of storm waves in the cross sea, first deal violent blows on one side and then on the other, to which this rock does not yield, and this violent collision first strains the ship, next takes the sea on and over her, and at last injures her structure, and may break her up in the end, and send her down.

3. Is there a middle form between these two which possesses the good qualities of *both* without the faults of *either*?

To discover this form is the problem you have set me. This problem I have undertaken, but I do so with a deep sense of its difficulty, both as to the perfectly precise, true, and exact solution of the problem, and especially as to my ability to make so deep and complex a question a matter of verbal explanation. But I have one comfort, I am glad it is *you*, the practical and experienced men of the sea, who have asked me for this explanation; that tells me that you feel it to be a great want, and your asking me makes the solution of it a great duty, which I now feel bound to fulfil as best I may.

The problem has two parts:—

The nature of the stormy sea.

The nature of the seaworthy ship.

Whence the two questions—

I. How is the water behaving on the ocean when gentle winds make gentle waves, and how, otherwise, in storms and amid breaking waves?

II. How should a ship be built so as to behave well and keep gentle and quiet equally amid ocean waves in fine weather and ocean waves in tempest, tumult, and storm?

I. The behaviour of water in wind and storm is generally expressed by the words—waves, swell, and breakers.

We may, therefore, first take smooth water, and ask how it becomes troubled and stormy? To discover the answer to this question I had to devote ten years of continuous observation to the study of waves and water-motion, and to exact experiment and observation upon them. I will endeavour to give you the results in few words.

I found there were four kinds of water waves, all quite different in nature. The skin wave, the surface wave, the ground swell, the unseen wave.

1. *The Skin Wave*.—If you look at a smooth sea on a still day, you will see here and there gentle wrinkles on the face of the water; they may be long though small and narrow—mostly quarter of an inch to two inches broad—like threads or ribbons skimming along the smooth, shining, mirror-faced water. These are caused by gentle airs in still water, and also by under-water currents in disturbed water. You can make them by moving a slender thread or line along the water, as in fly-fishing, or by cutting the skin with a penknife as you row gently along smooth water.

I found that these beautiful little waves were the consequence of a strange fact then unknown. The surface of the water where it meets the air is parted off from above and from below by a solid, strong, tough skin, quite unlike the water below: it is hard, unyielding, and solid, like ice. If ice were tough and would bend easily, I should call this skin "ice;" but ice cracks when you bend it. This is so tough that it bends easily; you can cut it with a knife, but it requires a pressure of about half an ounce to an inch to cut or split it, or $4\frac{1}{2}$ lbs. to the foot is the limit of its toughness; it is like leather rather than ice. In bright sunshine in a clear stream you can see it play all sorts of tricks, and you can see the wind and the fish and flies playing all sorts of tricks with it. The skin waves cover the surface with wrinkles on the first approach of the wind.

2. *The Surface Waves*.—The first symptom of coming wind in smooth still water is a series of long lines of skin waves, each not more than 2 inches broad. As the wind advances it soon makes itself felt by heaping up the wrinkles of the skin waves into piles and rows and ridges, growing from 3 and 4 inches wide and $\frac{1}{2}$ an inch high, gradually on to 3 and 4 feet wide and $\frac{1}{2}$ a foot high.

The standard wave, by which I measure and compare the times and speeds of all other surface water waves, is as established by my original observations, 1834—1844.

FIG. 4.
Standard Surface Wave.



One second time. Speed 3.57 feet".
Limiting height one foot.

The Standard Wave. { 3.57 feet long, from crest to crest.
 { 3.57 feet per second, speed of travel.
 { 1 second of time—duration.

The model wave, by which I measure the form and calculate the phases

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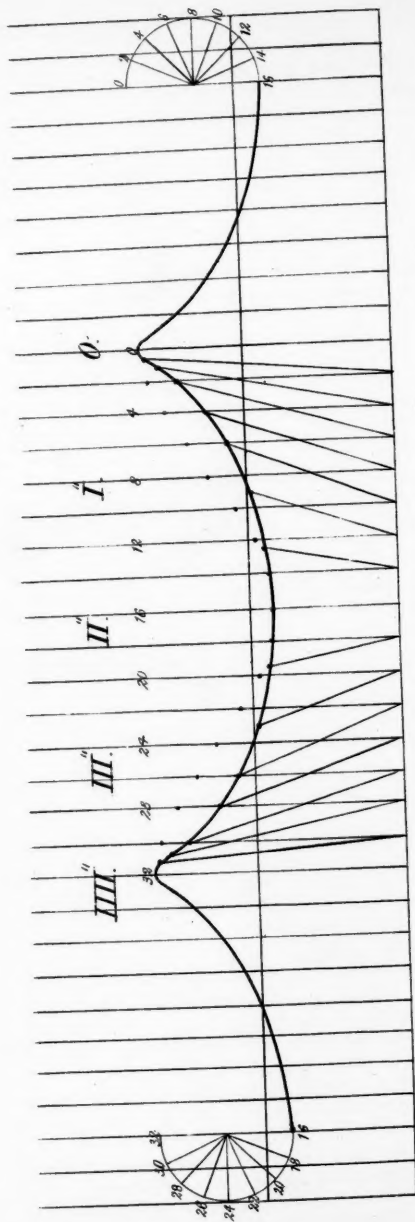
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Model Wave, 8.35 ft. high (100 ins), 57.12 ft. long. (16 Standards), four seconds time (III).



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and heights and rise and fall of waves is as shown in the large Diagram. (Plate XXXV.)

The Model Wave. $\left\{ \begin{array}{l} 8.33 \text{ feet high.} \\ 57.12 \text{ feet long.} \\ 14.28 \text{ feet a second speed of travel.} \\ 4 \text{ seconds of time—duration.} \end{array} \right.$

All other waves of this order may be thus calculated by the standard.

TABLE I.

Table of Surface-Sea Waves. Calculated by the Standard.

Time.	Lengths.	Speeds.
	Feet.	Feet.
1	1. Standard = 3.57	3.57
2	4. Standards = 14.28	7.14
3	9. " 31.63	10.71
4	16. " 57.12	14.28
5	25. " 89.25	17.85
6	36. " 128.52	21.42
7	49. " 176.93	24.99
8	64. " 228.48	28.56
9	81. " 289.17	32.13
10	100. " 357.07	35.70

Heights of surface waves are *not* inserted in the table for important reasons.

The chief reason is isochronism. It may seem strange, but it is exactly true, that a wave of given length and given time may vary in height from highest to lowest, and yet never take longer or shorter time to go through its changes of form or changes of place.

But there is an extreme or limiting height to each wave. This may be called the breaking height. For the standard wave it is *one foot*.

All waves of the lower heights behave in similar ways, and keep time with each other and with the normal or ruling wave.

But whenever circumstances, either under water or above water, such as wind and storm, or rock or ship, or one wave interfering with another wave, tend to push the wave higher up than this normal height, order and time-keeping may be destroyed. The wave then breaks, its parts are separated, and they spread abroad.

When a wave breaks, order and time-keeping are destroyed, rule ceases to be obeyed; the particles of water go each one its own way; the union under rule and order which constitutes a wave-community ends; the drops of water going each its own way—it becomes chaos, anarchy, disorder, ruin; the wave broken up disappears for ever; the dead water exists, the living wave is gone!

How and why all this takes place and ends in wave destruction, and often in shipwreck, I cannot explain until I have gone further and deeper into the question, and shown you what is the rule and order which governs each individual water-drop, under the surface, and the sum total of which make up the wave-mass.

3. *Under-Water Wave-Motion.*—The waves which we see on the surface of the sea have forms of beauty, which this diagram shows; and graceful motions, which this diagram measures; and their dances keep time, which this time-table tells; but all we see on the surface is semblance rather than truth.

What is happening under the water-level is quite different from what is seeming to happen on the water-face.

On the water-face, the wave seems to glide slowly or rush rapidly along one way; say, from the left on towards the right. Our model wave, with a running speed of near 10 miles an hour, rushes past with an impulse which, if it were real, would crush in the side of a powerful ship. But it does not crush or injure it. The water under the surface does not go past with the wave 10 miles an hour. It merely swings gently fore and aft, swells gently up and down, and remains in much the same place where the wave found it before it passed.

The under-water motions of sea waves are most instructive, and are the essence of our present study. To know what they are we must have spent years, as I had to do, in looking and searching, in shallow water and in deep water, to find out what each little round globe or drop of water in the deep sea is doing while the waves are dancing above their heads.

The result is what I have now to tell you, that each little atom of water is revolving, in a circular path, in the same regular way in which the moon goes round the earth.

During a long wave, each drop of water makes a slow revolution in the same time in which the wave travels its own length; and during a short wave it makes a quick revolution in the shorter time of the wave transit. Under a high wave each drop of water revolves in a larger circle, and under a low wave in a less circle, but always by law and order, just as a planet round the sun. It is the study of these laws, and the knowledge of these facts, that must teach us the nature of our ocean waves, and how we have to deal with them.

A first principle in water wave-motion is, that "the sea is full." This is little or ill understood. Even "great authorities" are misled and mislead others by neglecting this. They talk and teach about water and water lines and water streams as if they were plastic, accommodating, retiring soft groups, that were ready to take any shapes and make room for any other shapes and bulks, and give place to the intrusion of any other sort of body, if not too large and bulky to find room for.

On the contrary, pray remember that "the sea is full," and that there is no room under the surface for anything more than is there already; that is the first principle of complete wave-knowledge.

The first consequence of this principle is, that you cannot make room for a ship or for a mass of water, under the surface of the still water, except by lifting an equal mass out of the water, and setting it up above the water-level. One can only enter in by turning another one out. Place must first be found for one to be turned out of before another is turned in.

When a ship is launched from the slip on to the open water, an amount of water equal to her own weight, and equal in bulk to her

room in the water, is removed from below, and is absolutely laid in a heap on the top. The same is true of the water in a ship's way when she moves. Every atom of water in her way must have room for it found above the water-level. If the water be shallow and narrow, the water heaps up so high that it overflows all its bounds. If the water is wide and deep, the heaped up water on the top is spread out further, faster, and wider, and in the deep sea the displaced mass spreads out so fast and far and wide as to fill up so low a place in so thin a layer as to be scarcely visible, and this is the reason why this now settled fact was so long unknown, and may still be misunderstood or mis-stated. All the water removed out of the way of a sailing or steam ship must find room on the top of the sea, for there is no room left below.

A second question rises here. What will happen to a still, full sea, if, by any huge force, a mass of water were lifted off out from its level face? The first answer is, that some of the water below would spring right up into the hollow. The next answer is, that some of the water left around would tumble into the hollow. That is true, but more must follow. That is not enough to fill the void.

To fill up the void, some other void must be made elsewhere! The water cannot rest around a hollow till water has been fetched from some other place, far or near, to fill up the void; so, where a void is made, we must seek far and wide for means to fill that void.

Now, we have two results of any action on the face of still water. 1. A heap of water added cannot stay, it must go away and find a new place elsewhere. 2. A hollow scooped out of the water level cannot remain there; enough water to fill in must be sent there from elsewhere.

A water wave is merely an engine or mechanism or apparatus for doing this work of restoring the disturbed water-level. It does its work admirably, and we have now to see how the storm stirred up by wind is undone and set right again by the waves after the storm goes past.

I begin with a hollow scooped out from the surface of still water. This hollow is filled from opposite sides, by waters falling contrary

FIG. 6.

Surface water scooped out.



FIG. 7.

Falling in. Filling up. Falling in.

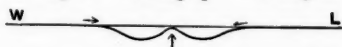


FIG. 8.

Falling in. Full swing upwards. Falling in.

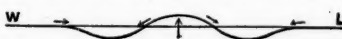


FIG. 9.
Oscillating.



FIG. 10.
Oscillating and spreading out.



waves. These opposite waters meet, strike, rise up, and form a central heap. This heap falls, fills the hollows it had left on either side, and they, thus filled, also heap up in pairs. Two more heaps fall in on two sides, leave two more hollows, which are, in turn, filled by meeting and clashing heaps. Thus there comes the odd numbers of three waves, five waves, and seven waves, so well-known to sailors as the groups of the sea. There is the one central largest wave, then two smaller ones on each side, sometimes accompanied with more smaller still, making five, or even two more, equal seven. (See Figs. 6, 7, 8, 9, 10.)

4. *Forces and Speeds of Water in Waves.*—Happily for us there are one or two simple principles of universal motion, expressed in formal laws by Sir Isaac Newton, which enable us to measure water motions just as he measured planet motions. His law of the apple falling from the tree is all we want, only he did not tell us how, after the apple fell from the tree, it was to get up there again, and that is what we have to settle. We readily see how the apple falls, but even Sir Isaac Newton did not accurately show how to get it up again.

Hydrodynamic science or water motion has this great aim—to settle the relations of height, depth, speed, time, and force.

The first law is called the law of height due to speed, and speed due to height. The law is as follows:—

The fall of a drop of water through 1 foot of height is done in a quarter second of time. The speed produced in the water by this foot-fall is 8 feet a second, or over 5 miles an hour.

The fall of a drop of water through 4 feet of height is done in half-a-second of time. The speed produced in the water by this fall is 16 feet a second, or over 10 miles an hour.

The knowledge of this simple fact enables us at once to settle the following points:

A surface wave a foot high above the level, if falling free would take one-quarter of a second to fall, another quarter to get up again. Also, if it had to go down into a hollow of a foot deep, and to come up again, it would take two quarters more. Thus a wave a foot high with an equal hollow might be expected to accomplish its work in four quarters of a second. This is what it does in our standard wave, with some modification in manner.

The modification in manner of fall by wave-motion is what is called the principle of isochronism. Our standard wave has the remarkable quality, that whether it falls from 1 inch high, or from 2 inches high,

or from 10 inches high, it occupies just the same time, viz., 1 second to complete the wave.

The principle of isochronism is this—that if you confine a force and apply it in such manner that you can vary it just in the proportion of the work to be done, you will do the more work in the same time as the less work.

Now this nature wanted is the exact nature of a water column.

Take a water column, say in a glass tube, with its lower end in the water and its upper end open, now close the tube with your finger and raise up a column of water, say a foot high above the level, then open the top of the tube and let the water column descend, and mark what time it takes; next raise only 6 inches, keeping everything else alike, and the descent through 6 inches will take the same time as through the foot.

The reason is this—the tall water column had twice as far to go, and twice the work to do, but it was twice as strong from its double height, and so did the double work in the same time. Wave heights are water columns—before they get down to or below the level, they must move the water under them out of their way—that is their work. When twice as high they do twice the work, and do it in the same time, all else being equal.

The next law I will call the law of equality all round, or if you like Greek words better than English, I will call it hydrodynamic homology.

I mean that this speed due to height in hydrodynamics, applies equally to water motion in all directions. Thus in the hollow of a wave, the water below the level pushes upwards as fast and as far as the water above the level pushes downwards, and does its work in the same time.

I next mean, that under a wave or water column a foot high, the water will go forward with the speed due to the height, just as well as upwards; and backwards just as much as downwards.

Without going into further detail I merely wish you to notice, that with these units in your mind, of 1 foot high, one-quarter second time, and 8 feet a second of speed, you can always measure what a mass of water is doing when it drives another of its own size anywhere anyhow.

Now surface waves are merely masses of water displacing one another successively, in place and out of place, by these few simple laws—of due height, due depth, and due speed—moving and keeping time in isochronic columns, and distributing moving force equally up and down, to and fro, in settled direction determined by the moving cause.

I took the scooped-out wave first, because that is the type of what I call the oscillating wave. The heaped-up wave is quite of another type, which I call the travelling wave or wave of translation, or, as it is sometimes called, the carrier wave, or the solitary wave. A high heap of water, let into or set up upon the top of still deep water, does not create a family group of waves. It remains a single solitary wave; it has no oscillating or backward and forward motion; its

motion is all one way. It is the nature of wave to which we give the name of "swell." It is much longer and faster than the surface waves, and its action goes deep down into the water, and reaches to the bottom, while the action of the other waves stays near the surface. Hence we call it "ground swell."

Now both these classes of waves, the wind waves and the ground swells, perform this function, they restore the equilibrium of the water. The hollow made by the scooping action of the wind is spread out in a thin layer, all over the top of the water, as far as the wave can reach; while the heap raised up by the wind is also rolled out into a thin film and spread all over the top of the water. But the solitary wave or ground swell performs a very different function. It carries off the heaped-up water to far off seas and shores, and spreads it all over the sands and shallows, where it expends its force in heaving up sands and rolling up pebbles and turning into fragments the rocks on the bottom of the shores of the sea.

The effects which these motions under the surface and on the surface produce on the ship, which is afloat upon and within the body of these waves, is what we must now seek.

What we have chiefly to keep in mind is that on or near the wave-crest the water in the wave is flowing forwards; that in and near the wave-hollow the water is flowing backwards; that in and near the middle of the wave-front the water is flowing upwards; that in and near the middle of the wave-back the water is flowing downwards. (See Figs. 11, 12, 13.)

FIG. 11.

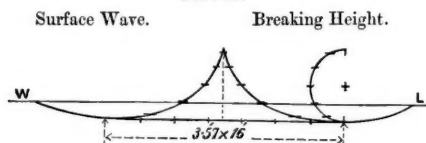


FIG. 12.

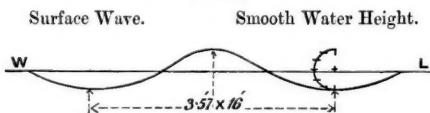
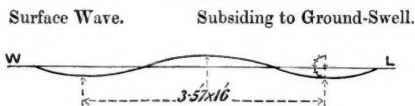


FIG. 13.



We have next to bear in mind that a water-borne ship will rest on the summits of these water-columns.

FIG. 14.

Pair of Hollows. Pair of Heaps.



FIG. 15.



FIG. 16.

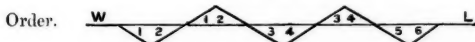
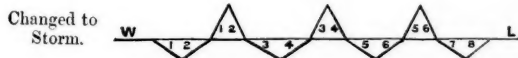


FIG. 17.



Water Motions in Waves along the Circular Paths of Water Particles.

Half wave Heights.	Pressure per square foot.	Speeds of water motion.
1 ft.....	64 lbs.....	8 ft. per sec.
2 „.....	128 „.....	11 „
3 „.....	192 „.....	14 „
4 „.....	256 „.....	16 „
8 „.....	512 „.....	22 „
16 „.....	1,024 „.....	32 „

Thus, therefore, the waves which cover the surface of the sea are masses which seem to fly hither and thither, and keep exact time, and seem to flow on with high speed. But this is an appearance only; the reality is that the masses of water remain in the same places or change only through a small range, while the waves in shape seem to fly afar. In each portion of one wave the water-particles are going each around in its own circle with a uniform known speed. Through one quarter of its cycle it goes upwards, through the next quarter forwards, through the third quarter downwards, and through the last quarter backwards to its old starting-point. Then begins a new cycle of the next wave.

These phases deserve careful study on the large diagram. (Plate XXXV.)

It is to these wave-motions of the water particles that we must pay careful attention if we are to create ships which shall suit the motions of the waves, and which shall neither disturb the motions of the waves needlessly, nor be themselves needlessly disturbed by them.

Monday Evening, June 9.

VICE-ADMIRAL E. GARDINER FISHBOURNE, C.B., Vice-President,
in the Chair.

PART II.

At our former meeting I limited myself to the investigation of the origin, nature, and effects of what I called surface-sea waves, as these are the most common and most visible on the ocean in storms. I will now proceed to the examination of another class of waves, quite different in nature and effects from surface-sea waves, although both may equally have their origin and do their work in one and the same storm.

The other class of waves may have several names—

Waves of the deep.

Ground swell.

Rollers and breakers.

Earthquake waves.

Tidal waves.

Cyclone waves.

It is essential to understanding this class of waves to make it clear in our minds that the two classes are quite different in all their phenomena, although the same laws of hydrodynamics govern both, and they may often have, or seem to have, the same origin. Each explains the other not as its like, but as its contrary.

As we have already seen, surface waves may appear in groups—a central one, two side ones, two more, and two more, diminishing outwards. (See Figs. 6, 7, 8, 9.) They may also have one leader and

FIG. 6.

Surface water scooped out.



FIG. 7.

Falling in. Filling up. Falling in.

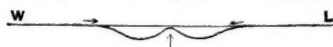


FIG. 8.

Falling in. Full swing upwards. Falling in.

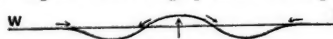


FIG. 9.

Oscillating.

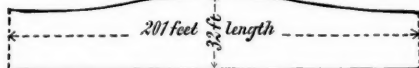


FIG. 10.
Oscillating and spreading out.



a following. (See Fig. 10.) But I have now to introduce to your notice a wave of the deep, with no leader and no follower. Hence he is sometimes called the solitary wave. This wave of the deep

Standard Deep Water Wave.



6.28 seconds time. Speed 32 feet".
Limiting wave height = Still water depth.
Height of wave-crest above water bottom, 32 feet.

FIG. 21.
Shape of Ground Wave.

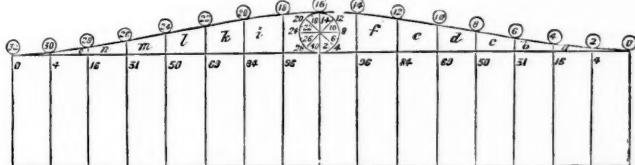


FIG. 22.
Water Columns in
Ground Wave.



FIG. 23.
Water Mass moved during
Wave Transit.



travels with great speed, from 10 miles an hour in water 6 feet deep to 600 miles an hour in ocean depths. (See Figs. 5, 21, 22, 23.)

This wave of the deep carries any force committed to it to any distance in short time, and delivers it up at that distance entire, with only the percentage due to imperfect fluidity of water. Hence I have sometimes called this "the carrier wave."

This wave leaves no hollow, has no follower; it finds the water still and leaves it still; it does not repeat itself. This wave lifts every particle of the deep beneath it a little upward, carries it a good deal forward, then lays it gently down again to rest, but in a new place; and it does this to every particle of the deepest water over which it passes. Hence from this power of water-moving I have called it "the

"wave of translation." Because it does its work right down to the bottom, it is also called "the ground swell."

This wave as a carrier will take the forces of a storm or a hurricane from any part of the sea with a speed much greater than the storm itself, and will deliver them on a distant sea-shore long before the storm itself reaches that shore.

The following is a table of the speeds with which a wave of the deep will carry its force and do its work afar over the ocean.

Table of Deep-Sea Waves.

Deep sea. 8 ft. deep.....	Carrier speed. 10 miles an hour.
32 " 	20 "
128 " 	40 "
512 " 	80 "
2,048 " 	160 "
8,192 " 	320 "
32,768 " 	640 "

If an earthquake sent up its force from the bottom of the sea in a great wave to the top, and the depth of the sea were 100 fathoms, this water-wave would carry the effect along the deep at over 80 miles an hour and would deliver the equivalent mass of displaced water in a destructive flood over a shore 1,000 miles off twelve hours afterwards.

Transformation of Waves.

Model Surface-Sea Wave transformed into Model Deep-Sea Wave.

How a surface wave, created by the force of the storm, is to be transformed into a ground swell, and so carried away to a distance, remains now to be examined.

Let us select for our first experiment the model sea-wave already given in our table.

Model Waves.

	Time.	Length.	Height.	Speed.	Volume.
A....	4".....	57.12....	2 ft....	14.28....	57 ft.
B....	3" 1416.	50.26....	2½".....	16.047..	57 "

A is the sea-surface wave; B is the deep-sea wave nearest to it. The two are of nearly equal volume. B is the faster and the higher and the shorter.

What is necessary to transform this surface wave into this ground swell is this inevitable condition, "that the water shall shoal up from "the bottom to less than *eight feet deep*."

When this happens, what was a negative wave will have its hollow below the surface filled up by the upward pressure of the rising bottom. It will cease to be hollow. It will have become a ground swell, and have all the characters of a wave of translation. It will have the same moving mass as before, and be slightly faster. But its speed will thereafter increase and diminish with the change of depth.

From our table of surface waves, let us take another longer and faster wave.

Another Wave, transformed.

Time.	Length.	Height.	Speed.	Volume.
C 9"	289 feet	8 feet	32 feet	1,156 feet.
D 6"-28	201 "	12 "	32 "	1,206 "

C is the surface-sea wave taken from the table. D is the nearest deep-sea wave of like speed.

201 feet is the wave-length due to that time in 32 feet depth of water, and 32 feet is the *depth of water* for the wave of 32 feet speed. The resulting waves are nearly equivalent.

The result of this transformation will be that the swell wave will retard its motion in 18 feet deep to 24 feet speed, and will accelerate its motion in 50 feet of water to 40 feet speed. That, in the shallower water, its height will rapidly increase, and in the deeper water will rapidly diminish, while the wave-length will diminish and increase in converse proportion.

One Solitary Deep-Sea Wave.

Time.	Length.	Speed.	Deep.	High.
20"-42	2,122 feet	104 feet	338 feet	30-528 feet

Volume.	Translation mass.	Tons.
32,260 feet.	96 feet	924 tons.

This solitary deep-sea wave is an example of the important influence of depth of water, on the speed and length and mass of a wave. A surface-wave of 20" time would be only 1,428 feet long; this is 2,122 feet long. The speed of the surface wave is only 71.4 feet a second, and of the deep wave is 104 feet a second. The waves, if of like height, would differ in mass nearly as 2 to 3.

TABLE II.

Table of Deep-Sea Waves or Ground Swell. Calculated on 32 feet as Standard.

Sea depths.	Wave-lengths.	Wave-time.	Transmission speed.
Feet.	Feet.		Feet.
32	201	6"-28	32
50	314	7-85	40
72	452	9-42	48
98	614	10-99	56
128	804	12-56	64
162	1,016	14-15	72
200	1,256	15-70	80
288	1,808	18-84	96
338	2,122	20-42	104
450	2,826	23-45	120
512	3,216	25-12	128
648	4,076	28-31	144
722	4,536	29-82	152
800	5,026	31-41	160

The comparative study of Table I of surface-sea waves with Table II of deep-sea waves will show the wide difference between the two in time, speed, length, and nature.

The surface-sea wave is comparatively short and high. The deep-sea swell is long and low.

The surface-sea wave of 4" has a speed of 14.28 feet. The deep-sea swell of 3".14 has a speed of 50.26 feet.

The mass of water in a surface-sea wave of 4" may be 200 feet.¹ The mass in a deep-sea swell, of like time and height, may be 700 feet.²

Under-Water Motion in Deep-Sea Waves.

The remarkable characteristic of under-water motion, in deep-sea waves or ocean swell, is that the motion is all one way.

In deep-sea waves the motion of the water-particles is forwards, in the way the wave is going. This is why it drives drift from the bottom of the sea towards the shore, and there heaves it up.

An up and down motion is combined with this forward motion, but there is no backward motion.

The motion of the water is, as it were, a semi-circular leap forward. (See Figs. 21, 22.)

FIG. 21.
Shape of Ground Wave.

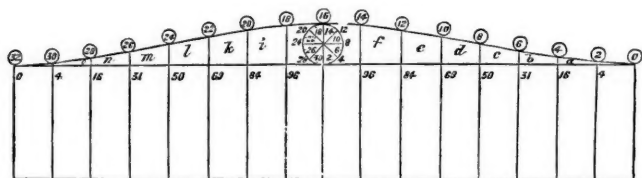


FIG. 22.
Water Columns in Ground Wave.



This circular leap forwards and upwards is flatter near the bottom and rounder near the top of the water. (See Fig. 22.)

¹ These numbers are the weight and volume of each foot length of the ridge.

² Reckoned for each foot along the wave ridge.

FIG. 22.

Water Columns in Ground Wave.



But the particles in the same upright line leap all at once, spring each a different height, but leap all the same distance.

The time the leap of each particle occupies is the time of the wavelength. All, in one upright column, start at the beginning of the wave and alight at the end in perfect rest, and remain there until another wave follows.

This leap is the motion of translation caused by each deep-sea wave on ground swell. There is a permanent change of place in the water; not a passing change.

The distinctions between the under-water motions of surface waves and of ground swell are best expressed by saying that, while the water particles in the surface wave move in complete circles of rapidly diminishing size, the water particles in the deep-sea wave move in half circles, gradually flattening, but not diminishing in span, all the way down, as shown in Fig. 22.

Complications of Waves in a Storm.

If there were only one single group of waves in one steady strong breeze, I do not think that their growing size, however great, would seriously endanger a good ship. It is the complication of different sets of waves, coming from different sources and in quite different states, which produces confusion, chaos, and danger. A sailor knows full well how to lay his ship's head for a single set of waves, and is not afraid of their behaviour.

To understand a complicated sea, let us begin by conceiving a long low deep ground swell to have set steadily in upon a smooth sea. The waves are long, low, and gentle. We are in 48 fathoms of water. Waves, 6 feet high, swell gently upwards, 600 yards long, from crest to crest, and pass us, three in each minute. There has been a storm somewhere. The long, low waves of the swell are travelling 60 miles an hour; so that a storm, 360 miles away, may be coming towards us, and, as storms travel from place to place much slower than these waves, we have some hours to prepare. If we are in the Bay of Biscay, where I have watched them, these swell waves may be coming from the north-west.

By-and-bye, a smaller second set of waves sets in, shorter in time and space, from the north, and crossing the ground swell at four points, we have one set of wave-ridges overlapping the others and many more

in the same space. This is a much nearer storm, as these surface waves are fresher and travel much slower than the ground swell. They are five to a minute, and over 600 feet long. They only travel 32 miles an hour. They come from a storm much nearer.

We have now a ground swell of waves three to a minute and 600 yards long: and also a series of surface-sea waves five to a minute and 600 feet long. If they were all in one direction their combination would be simple, as the surface waves would move along the ground swell just as though it were still water. But as they cross at a difference of four points of direction their crossings are more complex, and not easily seen in one plane.

Now the storm has come nearer, the wind blows from the north-east with violence, and the waves are now shorter, sharper, and quicker. The third group of sea waves are square across the second, and at four points from the ground swell. It is these last crossing the others, being crossed by them, changing direction with the chopping wind, and whirling about with the eddies of the blast, and over-riding the two previous series of waves, that make confusion twice confounded.

Storm Breakers and Shore Breakers.

Up to this point we have had the storm nearing us and gradually growing, but we have not yet had the worst of it.

So long as waves are of certain limits in size, even three or more discordant groups might co-exist without dealing destruction to ships or to each other.

But when we pass the breaking point, destruction threatens equally the waves themselves and the ships they carry. It is necessary now to study wave breaking: whence it comes, and what it means.

The Shore Breaker.

The shore breaker is the deep-sea wave rushing to destruction; to understand this we must go back to the beginning.

I told you that the surface of the sea has a skin covering—of great density, very tough, but very thin. On it the gentle winds make wrinkles or skin waves—the biggest wrinkle is about 2 inches broad, and it requires a force of some 4 lbs. to the square foot to tear asunder the skin.

I asked you to conceive of water in the sea as though it were so much liquid stuff stowed away in india-rubber sacks all set up against each other, upright in rows all pressing each against the other. This allows these bags to be squeezed out of one shape into another, but without any of the water which fills them ever getting out of any of these bags. There is no loss or waste so long as this condition is kept.

Wave breaking is really the breaking up or the bursting open of these water bags. When the bags are burst open, the drops of water no longer hang on by each other. Every drop rushes off on its own wild way; time in motion is no longer kept—all bond of order is

gone; thousands of atoms of water are tossed about in wild confusion.

The reason of this I will now show in the deep-sea wave. We know the speed of a deep-sea wave, it diminishes in a given ratio to the diminution of the depth as the water shoals towards the shore. In 48 fathoms of water our deep-sea wave is going 60 miles an hour, and may be 6 feet high. In 20 fathoms water it is going 40 miles an hour, and its height is above 12 feet high, and has shortened to half its length. In 9 fathoms water our wave-speed has gone down to 30 miles an hour, and its height gone up to 25 feet. In 6 fathoms water the wave will be 36 feet high, and from that point on towards the shelving shore there will be one continuous breaking cataract, pouring the whole volume of the water it contains out of the burst bags which contained it until every drop has been dispersed, and all of them laid out in a great white foam along the beach, or thrown up against rock or beach or breakwater with a violence which will make the deluge spring up 30 to 40 feet high, dealing out destruction or send the frittered spring in magnified recoil 60 or 100 feet up on the cliffs.

That is what I call a breaker of the first order or deep-sea breaker. The reason of this destructive violent rupture and dispersion is this: the wave form has a certain fixed speed of its own; that speed in deep-sea waves is taken from the depth of the water; but the wave-speed is quite apart from the speed of each atom of water. The wave has its own speed, but the water has quite another and a much slower speed. While our wave was going 60 miles an hour, the water atoms in it were going less than 16 feet a second; but as the wave went on to the shallow it went slower and slower, while the accumulating mass in the shortening and rising up wave became higher and faster, and in doing so each water atom was compelled to make a higher and farther leap. At last the wave-motion showed so much, and the leaps of the water particles grew so high, and they sprang so far, that the wave-bags burst, and each water-particle going higher and further than the wave could follow it there was an end of common movement and common bond, and each water-particle rushed with its own speed and force wildly spent against whatever obstacle, rock, ship, cliff, or beach came in its way; the water became a wide-spread flood, and the wave had ceased to exist.

The Storm Breaker.

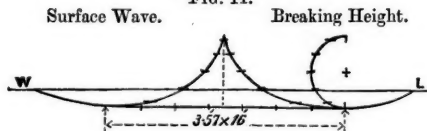
That wave we have just followed from the deep sea may have been originally a surface-sea wave, generated by wind far away in the fathomless ocean, and slowly transformed by shallowing depth into a wave of the deep or ground swell.

But there are also breakers on the surface of the sea in waves which never reach the shore, nor go so deep as to feel the bottom.

How they come to break we should now examine. For the study of this subject we may take a wave of each kind. (See Fig. 11.)

A Surface-Sea Breaker.

FIG. 11.

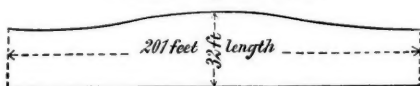
*A Deep-Sea Breaker, or Ground Swell Breaker.*

Waves which feel the bottom of the sea only break by shallowing in the following fashion: as the water shallows they shorten, as they shorten they rise. When the shallowing depth and the rising height of wave become equal, breaking begins, and goes on as long as the water shallows. If it deepen again, the wave will cease to break, will diminish in height, will increase in speed, and grow in length, and resume its first speed and bulk.

The reason of this equality of height of breaker and depth of water is, that the speed of the wave depends on the depth, while the speed of individual water atoms depends on the height, and both in such manner that when depth and height become equal, the water speed equals the wave speed, that is, the condition of tottering equilibrium, after which the slight excess of height of wave or diminution of depth upsets the balance, and the faster motion of the water atoms removes them out of the wave, and severs the bond between it and each other. The wave diminishes rapidly as the water leaves it and floods the shore, and once the water-particles are dispersed, and their time-keeping movement and wave-line bond is broken, the water becomes chaos and the wave ceases for ever. (See Figs. 5, 21, 22, 23.)

FIG. 5.

Standard Deep Water Wave.



6.28 seconds time.

Speed 32 feet".

Limiting wave height = Still water depth.

Height of wave-crest above water bottom, 32 feet.

FIG. 21.

Shape of Ground Wave.

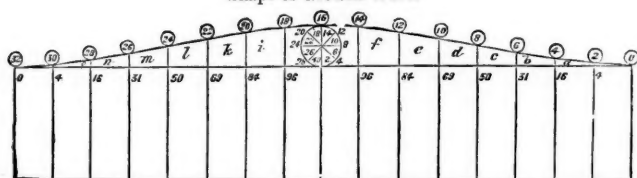
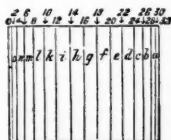


FIG. 22.
Water Columns in
Ground Wave.



FIG. 23.
Water Mass moved during
Wave Transit.



How the Wind Creates Breakers.

The direct pressure of the wind on a square foot of wave surface is—

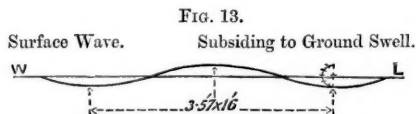
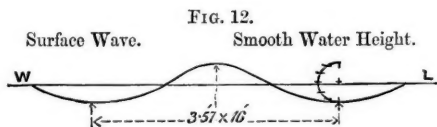
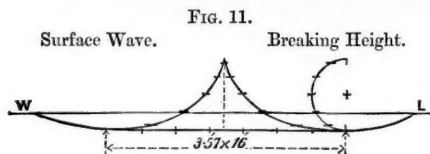
- 1 lb. for 20 miles an hour.
- 4 lbs. for 40 miles an hour.
- 9 lbs. for 60 miles an hour.

This is the result of my many exact measurements; it is more moderate at high speeds than the measures of others, which I think arises from errors in the instruments they used, and to these errors my instruments were not liable.

One cubic foot of salt water weighing 64 lbs., 4 lbs. is the sixteenth part of the weight of a cubic foot of wave. This force could communicate a speed of 2 feet per second to 1 foot of water in one second of time. Supposing then a surface-sea wave 4 feet high and 64 feet long to be attacked by such a wind, and taking the mass of 1 foot section to be 128 cubic feet, it would have a speed of 2 feet a second given to it in 32 seconds of time, or about half a minute, and in little more than 8 minutes it would be raised to 16 feet high, and have a speed of 32 feet a second; it might become a violent breaker, and might contain 7 tons of solid water in each foot of ridge-length, which, projected over an impediment, a ship or rock, would deliver a stroke of 20 miles an hour speed with a weight of 7 tons. If it were 10 feet wide along the wave-ridge, it would deliver a shock of 70 tons at 20 miles an hour, equal to the stroke of a railway engine collision.

Storm Waves and Stable Ships.

I think we may take it as the definition of a storm wave on the surface of the sea, as distinguished from a gentle wave or smooth swell, that the hollow below the water-level is the same depth as the heap of water is high above the level in moderate weather, and with moderate sea. But in the storm the wind drives the water-heap up to a sharp crest, which is three times as high as the hollow is deep. Thus the swell may be $\frac{1}{2}$ to $\frac{1}{3}$ of the wave-length in height without storm waves being directly created; but when this height is suddenly doubled by a sharp crest, driven up to near $\frac{1}{4}$ of the wave-length in height, the storm waves become breakers, and may be a source of danger. (See Figs. 11, 12, and 13.)



This rapid doubling of the height and sharpening of the shape by the violent wind, makes each individual wave a source of danger; but this danger becomes exaggerated by the complication of several series of waves in several directions at once, and each of these can mount on the top of the other, and so produce its own destruction as well as aid in the others.

Three causes lead to danger waves and breakers:—

1. The wind sending up the wave crest to a height two or three times greater than the hollow.
2. One wave summit rising on the top of another.
3. The water shoaling under a ground swell.

We have now seen enough of the shape of these waves, and learned enough of their under-water motions, and measured sufficiently the force of the wind on the waves, and the moving power imparted to the huge moving masses, especially when breaking, to be able to appreciate their effects on ships.

"The Rock" (Fig. 2), "The Raft" (Fig. 1), "The Ship" (Fig. 3), are the three types we have taken as representatives of "smooth-water stiffness," of "rough-water stiffness," and of the "storm stability," of which we are in search.

Take the rock of 48 feet beam, and 29 feet draft.

„ raft of 64 „ „ 20 „ „

„ ship of 56 „ „ 23 „ „

all of like shape, and tonnage, and different proportion.

The first with its weights very low.

The second with its weights very high.

The third midway.

The first would be steady and stiff, and would stand upright under canvas both in rough and smooth water. But it would be uneasy, and in a storm would be struck heavily by violent waves without

yielding, and might therefore suffer great damage in a storm by injury done to her structure; she would be struck like a rock by the sea.

The second would be steady and stiff and upright in smooth water, and stable in gentle waves, but would roll dangerously in a beam sea, would take in on deck the entire volume of storm sea waves, and might capsize.

The third ship, well trimmed, might avoid the dangers of the other two by good proportion and wise shape, which we shall now seek.

On Ship Shape.

That a good seaworthy safe storm conqueror may be constructed with high storm stability and gentle easy motion, so as to be neither rock nor raft, I can venture to assert as the result of many years of experience and observation. I cannot claim originality in such forms, as they are a tradition from the former generations of seaworthy ship-builders, and were expounded by the most distinguished of our philosophers and mathematicians. But I have arrived at their conclusions, although proceeding on quite different data, and following quite other methods of research.

In order to find out the most perfect form of ship for storm stability, I take a form of no stability, and then I seek to give it only that kind and those degrees of stability which I want.

The typical form of "No Stability" is the circle. A circular body, or barrel-shaped midship section, has the wonderful quality of absolute neutrality, of perfect indifference to attitude, and is equally endowed with stability or instability in a smooth calm or in a raging storm.

This quality of perfect neutrality in all seas is just that quality which enables us to handle it as we please, and give it just the degree and kind of stability we want.

If we take this round or barrel form and place in it, without change of shape, a very small portion of ballast, this small bias will ensure the circular form remaining always upright, even on the most troubled waves.

Supposing then such cylindric midship body to be weighted with sufficient ballast to bear up under the pressure of sail, by ballast alone, the waves would roll all around it without disturbing effect, excepting the two effects of rising and falling, pitching and scending. Its masts would stand up steadily under due pressure of wind, only inclining over to the due angle and press of sail.

But this shape and trim would have one fault. We do not wish a ship to stand upright, or to have a fixed and changeless inclination on a heavy sea. We wish our ship to careen gently over with the slopes of the swell; we wish our deck to conform gently with the slopes of the waves; we do not wish it to follow the violent changes of storm waves into their extreme and dangerous slopes; we wish our ship to stay half way between.

This medium motion we must now try to give our ship so as to stay equidistant from rock stability and raft stability.

The form which unites and reconciles these opposites we obtain as follows:—

Take a circular midship body of no stability—place it afloat at the intended draft of water—arrange all the weights so that the centre of weight shall lie in the centre of the circle—place all the heavy weights at the nearest convenient place to the centre of the circle—place no weight further away than is indispensable to its use.

This circular body is now afloat, carrying all its own weights, but entirely free of stability of any kind (see Fig. 18).

FIG. 18.

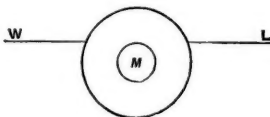


FIG. 19.

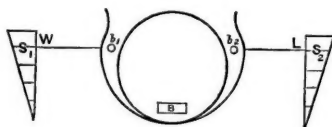
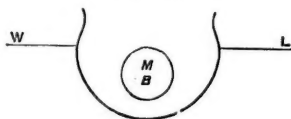


FIG. 20.



Next, take two triangular forms, which I call shoulders— S_1 and S_2 , Fig. 19—add these two areas of section to the circular section, then place low down in the hold their equivalent buoyancy in mass of ballast.

Thus, two sources of stability have been given to the unstable circle—shoulder stability and ballast stability, and an equal quantity of both.

Now, this shoulder stability, being only half of the whole stability, will give the ship easy motion on the waves and with them.

And this ballast stability will give the other half wanting to keep the ship vertical and maintain the action of the wind on the sails.

Thus we have halved each of the kinds of instability to which the ship is liable, and have provided the complete whole of stability the ship requires, and thus we have minimized the movements of the ship with the sea and minimized the careening power of the sails.

The size of these shoulders of the ship and the place of the ballast are matters of exact calculation, and must be suited to the purpose of each ship.

But, in modern steam ships, there are so many large and weighty

masses of matter, the wise placing of which should be at the disposal of her designer, that no difficulty in disposition of weight should require the ship to be burdened with valueless weight. Engines, boilers, water, and fuel give ample ballast, but they are sometimes unwisely placed, and do harm.

It will be readily seen how this form, with its opposite halves and natures of stability, will have compensating natures of force within itself, preventing either motion becoming exclusive or excessive, and, therefore, the tendency to oscillation through large arcs from internal causes is minimized.

It will equally be seen how this circular form evades all the forces from causes external to the ship tending to give it rolling motion. In all the classes of waves, we see that the under-water motions are circular. If, therefore, our ship were of an angular shape, or if it possessed the strange deformities called bilge keels, we could see how the circular vertical oscillations of water-masses in wave-motion would strike on these projections, with violent concussion or with accumulating friction, and how the waves would thus first communicate to the ship violent rolling movements and then, by contrary violence, bring it back to rest, thus performing much useless work and involving much waste. But the stable circular form has neither an instrument to disturb the free oscillation of the water in its wave circles, as they surround and embrace its body, nor has it any protuberances, corners, or flat boards upon which the revolving water masses can deliver their blow.

This form, therefore, has no internal source whence to obtain rolling and dangerous motion, nor has it any external instrument by which to impede or take up any of the storm forces raging around.

Conclusions.

I trust I have now answered all the questions I undertook.

1. A storm is that state of the sea where waves, which had equal height and hollow, have been driven so high that the height above the sea level is near threefold the depth of the hollow.

2. Smooth water on sea is not necessarily level water, but, so long as the height and hollow of the waves remain equal, it may be reckoned smooth water.

3. Stiffness is the ability which a ship shows to resist the tendency of wind and sails to incline it over from the water surface.

4. Stability is the ability a ship shows of not taking from the water the rapid changing attitudes which the water itself assumes in storm waves.

5. A storm is created on the surface of the sea by the excavation of a hollow from the level-water surface, and by the piling up of this excavated mass in the neighbourhood of the hollow. These two are always of equal volume. The force of the wind measures the height of these waves.

6. Smooth water returns after a storm, first by the descent of the wave crests from their threefold height to their equality of height and hollow; next, by the spreading of the heaps and hollows more and

more wide, until they exhaust their force on water friction, or until they break up on the sea shore, or until they create other waves, which take off their force to a great distance.

7. A stable ship is made by moderate beam, due depth, and by such shape and weight as neither to oscillate from internal cause nor to suffer injurious movements from without, which stands up without becoming uneasy, and leans over gently without jerking against the waves.

8. A ship is made stiff either by much beam or by much bottom weight; the least quantity of either that fulfils the useful purpose of the ship, is the best.

9. The nature of surface-sea waves, as distinguished from the nature of deep-sea waves, is that they do not agitate the water much below the surface, however violent their motion may be on the surface. A wave 36 feet long, even if 9 feet high, would produce scarcely any motion 18 feet down; the motion of such a wave 36 feet long would not ordinarily be more than 4 feet, 2 upwards and 2 downwards, except in a storm. While each water particle moved 2 feet up and 2 feet down, it would also move 2 feet forwards and 2 feet back, thus performing vertical circular motions with steady speed. While the wave seems to fly onwards, the water really remains going round in a place either fixed or slowly changing.

10. The nature of breaking waves is this: that whenever the force of the wind is so great that the separate particles of water sent up into the summit of a storm wave receive a more rapid motion than the wave form already has, the particles moving faster than the wave, upwards and forwards, leave it, take each their separate way, and the wave is dispersed, diminished, perhaps destroyed. Or, if one wave overtops another, the like effect takes place.

11. The ground swell differs from the surface wave in the fact of the motion of its particles descending all the way down to the bottom where they go as far forward as at the top; they go all forward and none backward; there is no hollow below the water level, and each wave is a large heap raised above the standing level of the still sea. They break, whenever the depth of water equals their height.

12. Storm waves are surface waves which, instead of having equal heights and hollows, have the water sent up by the force of the wind to a sharp crest, which breaks when about three times as high as the hollow; and, also, those waves which, by the force of wind changing direction, are driven to ride on the top of each other, and are driven over and clash and mutually destroy each other or the ship they strike rudely or which rudely strikes them.

13. A crank ship should not exist; it generally comes of narrow beam, or too great depth or top weights; it inclines far over with light wind or none; it makes long and heavy swings; it is dangerous, and only high freeboard can save it. Bottom weights lowered down or sent in are the common cure.

14. A stiff uneasy ship is the contrast to a crank ship. I have sometimes seen a crank ship made the better of the two; the crank ship yielding slowly and gently to the waves, and rolling too much,

but easily; while the stiff ship, with its own inside weights, was jerking with violent, short quick blows, from side to side, in collision with the waves. The removal of weights from places where they give and get violent motion to those places where they will move more slowly round a stable centre is the cure.

15—22. All these questions are already solved by the shape of ship shown in Figs. 19 and 20, and the distribution and stowage of weights as near to the centres shown as is consistent with the purposes of the ship must govern the rest. The evils we cannot avoid we may at least *minimize*.

DESCRIPTION OF THE FIGURES AND DIAGRAM.

Fig. 1 shows the midship section of ship which is stable in smooth water and unstable in a heavy sea.

Fig. 2 shows the midship section of ship which is too stable in all weather, and requires to carry much heavy weight low down. It is never easy, gentle, or lively, and is always fighting violently with the waves.

Fig. 3. The ship shape is always easy and lively, stable and gentle, having the exact measure wanted of surface stability for smooth water, and of uprighting stability for rough seas in a storm.

Fig. 4 is the standard surface wave. Each particle of water on the surface moves once round in a vertical circle during the same time while the crest of the wave moves forward. Just as a wheel goes forward while each spoke goes round, so each particle of water goes round a circle the way the wave is going in the same time in which the wave goes forward through its own length.

The Diagram (Plate XXXV), shows the details of water motion and of wave motion in a model surface wave, from which (as also from the standard, Fig. 4) the other waves may be calculated and measured. See Table I of surface waves.

This Diagram has the vertical columns of still water shown by upright lines. These lines sway back and forward at bottom and top of each wave. The water columns lengthen and shorten, while the top of each water column goes round a circle and at a certain depth below stands still. The water columns sway back in the hollow of the wave and swing forward on the crest. The motion of the wave is uniformly forward, the motion of each water-particle of the surface is uniformly round in the circle, and the rise and fall of the water corresponds exactly to the times and heights of the uniform circular motion. In short, the motion of each single water-particle corresponds to the motion of the hand of a clock, and keeps time with equal truth.

Fig. 5 shows another wave of quite a different nature from the surface wave. It is called the deep-water wave as distinguished from the surface wave, because the water in it moves as much at the bottom of the water as at the top and always forward, instead of backwards and forward.

It is called the ground swell because it always feels the bottom and tells the eye which can read its meaning, how deep the water is. It is sometimes called the wave of translation because it carries things forward the way it goes. Figs. 21, 22, 23 show the details of the deep-water wave.

Fig. 6 shows how surface waves are created. Wind or other forces scoop out a hollow, and the water resists, and pushes up water from below to fill up the hollow.

Fig. 7 shows the water below springing up to fill this hollow, while from both sides the water also flows in to fill it. These three meet and spring too high and fall down again.

Fig. 8 shows the water rising full swing upwards above the level forming a heap, while the two sides whence the water flowed into the first hollow are now emptied out, and two hollows remain on each side.

Fig. 9 shows a new state of things, results of the former. The central heap falls; the side hollows are filled from below.

Fig. 10 shows a stage further on. One central scoop, a couple of heaps on each

side, a couple of hollows formed on each side of these, and so this process goes on in odd numbers of waves :—

- One middle one.
- A pair of side ones.
- A second pair of side ones.
- A third pair.

Thus making :—

- 3 waves in a group.
- 5 waves in a group.
- 7 waves in a group.

And so on, either growing up or dying out, according as the moving force of the wind strengthens or dies.

Fig. 11 shows the surface wave with its two side scoops when it reaches its breaking height and becomes a storm wave. In this diagram is shown how the water scooped out of the hollow is piled up three times as high, and forms the summit load of the wave just before it breaks.

Fig. 12 shows how if the wind falls this wave subsides; diminishing its height till it is only the same height as the hollow is deep.

Fig. 13 shows how this equal height and depth continue until the wave disappears.

Fig. 14 shows the volumes of water moved.

Fig. 15 represents the places where they are moved to, in order to be set so as to form a wave.

Fig. 16 shows the order in which these heights and hollows must be set to form a continued series of waves in smooth water.

Fig. 17 shows the new attitudes these same masses take in a storm. The hollows remain unchanged in attitude, but the heights are driven nearer and set upright to the extreme of three times the hollow, after which they break down and become scattered.

Fig. 18 represents the form of absolute indifference, which may be called equally the form of no stability or of no instability. It is the form which the water does not disturb and which does not disturb the water—the slightest weight below its centre will keep it upright. It is a perfect float for carrying heavy weight placed around its centre (M); but is not a ship.

Fig. 19 shows how to make it a stable ship in smooth water. Two shoulders on the two sides are added to the volume of the ship. The exact measure of stability you want is given by the areas of these triangles and by the place of their centres when in the water, and thus the required measure of power to carry sail in smooth water is directly obtained.

Fig. 20 shows the shape of midship section of ship which is thus obtained. But as we have added to the volume of the ship the addition of the shoulders, we must now also add to the former load carried so much additional load in cargo, stores, or ballast. In placing this new weight we must either place it low down, so as to double the power of the shoulders in still water, or, considering it as part of the whole lading, we must lower the whole lading down to the place where it will produce a like effect. We have thus got our whole stability in two halves; one half in the power of the shoulders keeps the ship normal to the surface of the water, the other half, in the equivalent weight added below the centre, or in the whole weights lowered down, tends to keep the ship upright or vertical without reference to the water surface or wave surface. Thus, in still water both actions help to keep the ship up under canvas; in surface waves the ship is both stable, lively, and easy; in storm waves the uprighting stability steadies the ship, and the surface stability gives her easy gentle movements. Thus, in Fig. 20 we have the shape and the stowage of weights and ballast (M and B) which give equally storm stability and smooth-water stiffness.

Fig. 21 gives the shape of the deep-water wave or ground swell already described in the standard in Fig. 5, and here much enlarged. The circle in the centre represents time by the hand of a watch going round. As that hand goes up and down and round the circle, so the water surface rises and falls, and goes forward along the line, keeping true time and exact height. The times are shown in instants on the

curve, as 0, 2, 4, 6, 8, 10, 12, 14, 16 instants rising up, and as 16, 18, 20, 22, 24, 26, 28, 30, 32 instants falling down.

Fig. 22 shows how the water is moving in the deep water while that wave is moving along the surface. The water at rest is in vertical columns and these columns remain vertical throughout the wave transit. The figures above, 0, 2, 4, 6, 8, 10, &c., show how these columns march forward in the deep, while the wave on the surface glides along, as shown by the same numbers in Fig. 21, all keeping true time.

Fig. 23 shows the result left behind the wave 21 after it has passed away. All the water columns shown there have been marched forward out of their former place where they rested, and set down in a new place that length forward and there left at rest exactly as before. Fig. 23 is, therefore, a series of columns as found at rest and left at rest, and Fig. 22 shows the same series of columns as they are while on the move, under wave shape, Fig. 21.

Admiral FISHBOURNE: We are very much indebted to Mr. Scott Russell for his very clear and lucid exposition; his distinction between smooth-water waves and sea waves shows the real cause why there are such diversities of opinion with respect to the performances of ships. That has been entirely lost sight of, so ships have been compared in conditions that are totally diverse, and it is often assumed that because a vessel conducts herself well in particular circumstances, such as smooth water, she will necessarily conduct herself well in other circumstances. This is a dangerous mistake. We have never had the exhaustive examination of models when first produced, that we ought to have had. Examinations are not so extended as they ought to be; moreover, the persons carrying them out are continually changed; thus they are all learning their lesson instead of having experience and standard by which to measure.

Commander CURTIS, R.N.: I should like to make a few remarks with respect to that vessel that Mr. Scott Russell called the "Rock;" in nautical terms we should call it a half-tide "Rock." There were six vessels fitted out in Dundee or some port in the North, to go to the Yang-tze-kiang in 1864, which were called clipper barques, of great length and light draught, laden with railway iron, and I think from hearsay there were only two that ever arrived at their destination. One put in at Rio, she washed everything off the deck, rolled so that she flapped topgallant sails out of the bolt, and when she arrived at Rio she had to put bilge pieces on and to raise the ballast. I think you will recollect that when Mr. Porter the other day at the Society of Naval Architects read some interesting reports about the load line, some gentleman sarcastically remarked that the load line might just as well be on the maintop for all the use it was, and I think he was nearer the truth than is generally imagined. If you look at the papers every day, you will find, I think, that we lose on an average one ship a-day by foundering. The fact is, I suppose, there is very little stability in the way of stiffness on account of the disposition of the weights in the ship,¹ and they are really capsized in the trough of the sea. I agree with Mr. Scott Russell that the disposition of the ship's weights should be such that with her engines and 20 tons of coal, and boilers full of water, she ought to be able to stand up under her

¹ See *Standard*, May 21st, 1879. Missing ships between America and England—since 1841—number lost 145—26 missing, 80 wrecked, 6 foundered, 8 abandoned—1 capsized, 11 burned, and the rest sunk by collision.

Five new iron steamers lost this season were laden with grain, bearing out what I say, that grain laden vessels have very little stability, especially if they have compartments for *water ballast*, and those compartments empty, which I believe is the practice when laden, it tends to make the vessels top-heavy—and they are overwhelmed with the sea before they can right themselves. The paper remarks, "It seems hardly to admit of any doubt that a class of steamers have been placed in the Trans-atlantic freight business which are not adapted for *stormy winter seas*, or else there has been gross neglect in loading."—J. D. C.

canvas, I do not say in a gale of wind, but steamers going from one port to another for cargo may be reduced to 30 or 40 tons of coal, and have to depend upon the sails, in case of losing the screw, not infrequent in merchant steamers. To give a false bottom, I think makes the ship weak, and water is an objectionable thing to have in a ship, because you never know where a leak will be. The true ballast of a ship should be her engines and boilers, and she ought to be able to stand up under her canvas. I should like to say just one word about waves travelling. I know that running round Cape Horn, we often had very great fears of being pooped by the waves.

MR. WHITE: I am sure we must all feel, in listening to Mr. Scott Russell, what a master he is of the power of popular exposition; but I think sometimes that the wealth of his illustrations makes it more difficult to say anything that is critical concerning them. If, therefore, I now raise a question as to one or two of the "standards" which Mr. Scott Russell has given, I know he will take it that I am asking for information, and not disputing his observations. I have not the opportunity which he says he has had of personally observing waves at sea; but I have had the opportunity of studying the observations made by many naval officers in the French, English, and American Navies, and I find that the law connecting the length and period of waves is not that given on Mr. Scott Russell's table of "standards." Instead of the factor given by Mr. Russell—the convenient number for memory 3.57—I find that factor more nearly approaches the figure 5. In fact, taking the average of a very large number of observations, I find the so-called "trochoidal" theory (which would give the exact figure $5\frac{1}{2}$) is as nearly as possible confirmed. If any gentleman will turn to Mr. Antoine's long list of observations which have been recently published, he will find that having compared observations made in the French Navy, with Dr. Scoresby's observations and all the other observations on record, French writers have accepted the trochoidal law as their standard, and this makes $5\frac{1}{2}$ times the square of the period equal to the length of the wave.

MR. SCOTT RUSSELL: What is the seconds wave?

MR. WHITE: Five and one eighth feet. I do not mean to say that they have ever observed a wave having a second period at sea; I mean to say taking for example, waves of six seconds period, those waves would be over 180 feet long instead of being, as Mr. Scott Russell has it on his table, 128 feet long. Only to-day I happened to take up the observations made on board one of the ships which Sir Cooper Key has recently had in his squadron in the West Indies, and I found a record of waves of eight seconds period over 300 feet long. I only give you these as instances confirming my statement that the very extensive observations made in the last few years by naval officers do not agree with the standards given by Mr. Scott Russell. Then as to Mr. Russell's "pattern ship" I wish to say one or two words, from the naval architect's point of view. Mr. Scott Russell knows as well as any one that you could not possibly point to the circular cross section, those "shoulders," from which he hopes to derive such benefit, without affecting the position of the metacentre of the ship.

MR. SCOTT RUSSELL: I have avoided metacentre.

MR. WHITE: I know it is avoided in terms, but it is there in fact. I am accustomed to speak about the metacentre; Mr. Scott Russell is accustomed to speak about the shoulder; we mean the same thing. But I must add that the whole effect of the shoulders is not counted up when you take account of the consequent alteration in the position of the "centre of buoyancy." Mr. Scott Russell will admit that, I am sure. The truth is when you join to a circular cross section sections which are not circular—

MR. SCOTT RUSSELL: Of course I raise the metacentre, I assumed everybody knew that.

MR. WHITE: Then raising the metacentre—

MR. SCOTT RUSSELL: Gives me exactly the buoyancy I want.

MR. WHITE: It also takes away the very admirable quality which the circular cross section has, viz., that all the external fluid pressures are then delivered through the axis of rotation. If you have joined to the circular cross section those shoulders, you must lose that quality; I have been for a good many years connected with the

designing of steam ships with very large engine powers and "disposable weights" as Mr. Scott Russell puts it. Our difficulty however usually is to get the boilers and engines into ships at all, in convenient places; in ships of war, for instance, it is necessary to place the machinery under the water line, or under the protection of the armour. It may be different in merchant ships; I do not pretend to say much about their design, but it obviously embraces other and special considerations. But in ships of war, most certainly, from not a small experience I can assert that our chief difficulty is usually to get engines of the necessary power into the space available under the necessary conditions. So that, the vertical distribution of the weights of the machinery is not a thing which helps the naval architect so much as Mr. Scott Russell seems to suppose in governing the position of the centre of gravity. On a previous occasion in this theatre I remember Mr. Scott Russell also made a similar statement as to the effect of the disposable weights of machinery and boilers, and therefore, I now take occasion to say that in our experience in war-ship-design, that is not a thing that helps us to anything like the degree Mr. Scott Russell would suppose.

As to the general character of Mr. Scott Russell's remarks I join in expressing the thanks that we feel. I think his remarks on wave motion, in the main, express the views of all the most eminent authorities who have written on the subject. Of course Mr. Scott Russell puts his diagrams forward simply as rough indications of the internal structure of waves; but I must say this, that the breakers that Mr. Scott Russell has put on the board (or what we usually call "cycloidal" waves) are not the waves which sailors tell me often produce the most extreme rolling in large ships. And further I would say that the second "objectionable" type of ship, according to Mr. Scott Russell (his "half-tide rock" type) is pretty nearly the section of many existing merchant ships; and I am told that those ships, although very deeply laden in proportion to their beam, as a rule behave exceedingly well. I am now speaking of such vessels as the Atlantic liners which would often have 27 feet of draught on starting, with 40 to 45 feet beam—a proportion of draught to beam which in ships of war is scarcely ever, if ever, seen.

Admiral SELWYN: I think, Sir, we all join in our admiration of Mr. Scott Russell whenever he rises to speak to us. His facility of manner, and his happy illustration, command attention, and give us a great deal of instruction in a very short time. As regards his observations on waves at sea, most of my brother seamen will join me in saying that one of the most difficult things to answer a man can be asked who spends a long life at sea, is—What is the ordinary behaviour of waves? One man will tell you that he never saw a wave above a certain height, and he may have followed the sea quite as long as another who has seen a great many varieties much higher. It happens perhaps to a young sailor, who goes to sea for the first time, to get into a hurricane, while another may follow the profession his whole lifetime, and never come across one. And when we do come across hurricanes, this remarkable fact takes place, that although we should like very much if we wanted to see big waves, that the wind should blow over us in one certain direction for the greater part of the time during its period of touching the earth, that is just what it never does. Luckily for ships' existence, it is always turning round, and creating cross seas, which complicate the problem so tremendously, that the closest observers will tell you that they have very rarely seen a really steady sea. I think it is rather a disgrace to the profession that we should now regard the observations made by Dr. Scoresby in small vessels, as our only standard of information on the subject. I am quite sure, from my experience in the large Atlantic steamers, that they offer to us very considerable advantages for observation. They are of lengths which I will not say in the heaviest Atlantic seas, but in most Atlantic seas, are not surpassed by the wave length. In the "City of Richmond" and the "City of Chester," two of the longest of the Inman Line—over 400 feet long—I have observed that the wave entering under the stern was coincident, as nearly as possible, with the wave parting from the bow, with a following sea, in a gale of wind, at a speed of 16 knots, and under those conditions the depth of the wave was often quite inconsiderable, compared to what might have been seen in a heavier or a longer continued gale of wind. I regard the whole question of the action of the waves as one to be subordinated to the consideration of the downward friction of

each particle or atom of water, that is to say, the power of the superincumbent water moving over the lower water, and the frictional action so set up, to retard the wave. That there is a motion forward in obedience to the force exerted by the wind no one can doubt, but this is brought to rest in very large measure, as Mr. Scott Russell has shown, by that very frictional action which raises the wave, and the trochoidal theory showing the circular movement resulting from the friction below, is the nearest approach that has yet been made to the true movement of any atom of any wave. But with regard to the height to which waves can rise, Mr. Scott Russell must give us the conditions. If it blows a gale of wind into the Bay of Biscay, lasting for a certain time, the motion may be so far communicated downwards, that the wave which would not have been a breaking wave in the Atlantic, becomes a breaking wave in that depth of water owing to the frictional effect of the immovable bottom coinciding with the frictional effect of the partially movable water, and producing a break where there would only have been a slight cone. With regard to the speeds of waves, it would be very useful if we could rule the waves in parallel lines, but I quite agree in thinking that we may usefully study the question much further than we have yet done; that it is a fair reproach that the attention of sailors has not been more devoted to what their extremely accurate instruments enable them to do now much better than before, that is, to study the behaviour of their ships in waves which will differ with every form of vessel, with every mode of disposing of weights, and also even with the skill of the captains in meeting the waves.

With regard to the shapes of vessels which give storm stability combined with smooth-water stiffness, I venture to say that we have done a great deal to weight our vessels unnecessarily. I am most happy to hear the repetition by Mr. Scott Russell of an idea which has been long present in my mind, that he was not fit to be called a naval architect who puts ballast—useless weight—into a steam ship, particularly that that is the case when we have to deal with iron and steel ships—he is not deserving of the name of naval architect, for he has not made the proper calculations or he would not have to put in useless weight any more than the boy who knows how to cut out his wooden model well, will have to put a lead keel to the vessel to keep her upright. Now I want to know from Mr. Scott Russell is it a necessary part of the higher art of naval architecture that ships should have a normal position bottom up? Is there any good reason now existing more than existed forty or fifty years ago, why a ship should not be able to turn over on her beam-ends, and if you cut her masts away, or otherwise relieve her of the reclining pressure, come upright again? Is it or is it not simply due to a little want of consideration of the necessities of the problem and giving too great a weight to the difficulties which everybody must admit have arisen? Armour and artillery are no jokes; they have come as a necessity upon the naval architect; they are weights which have to be carried high up, and the form of the ship must be studied to carry those weights high up. Being a necessity we have to deal with it in that way. It is all very well for the merchant ship-owner to say "I will load a certain quantity of iron or other dead weight placed in a certain position, and I will carefully observe that the conditions under which that ship will behave well at sea shall be carried out faithfully," but the naval architect has that dreadful condition constantly being forced upon him that the weights of armour are increasing, the weights of guns are increasing, they all must be carried above water, and everybody is disposed, far from increasing the weights of engines and boilers, to decrease them as much as possible, while the coal carried will always also be subject to diminution by use. Now the question arises whether the forms of ships which were perfectly good so long as we had only to deal with certain weights, which we could dispose as we pleased, may not be usefully abandoned to a certain extent in view of the present difficulties, and I put it to Mr. Scott Russell as a question whether the only direction of meeting that difficulty is to make a ship so light below and so heavy above that if she goes over to an angle of inclination of 45 deg. in spite of ballast she will turn over and go down. This is a question which interests not merely *dilettanti*, or old officers, it is a question of life and loss of life at sea, a question which affects for all future time the lives of sailors. We want a navigable vessel which will keep the sea in all weathers, and we do not want to be sent to sea in anything, which however beautiful, will probably or possibly encounter weather which will drown the ship and

crew; and we do ask that naval architects shall give us a seaworthy sea-keeping ship, and we suggest to them that there are ways of doing it other than those we have yet adopted of putting all the weights up above, and all the buoyancy below, and then compensating for the position of the weights by putting a little useless weight into the bottom, and so giving us a ship which with a very steady gun platform has yet concealed in her the fearful danger that no one can ever know when he would meet such a wave or wind as would send it to the bottom, and no power on earth and no seamanship on earth could prevent the result. So much is that the case that sailors are forced into advocating the reduction of their sails simply in the feeling that there is no safety in having masts—that you cannot do it. This is a point on which I think the wise, scientific architect may very well step in, and with his comrades reason out the whole state of things. We sailors will be all ready to aid them with everything we can learn at sea, to obey their directions and study what they tell us we ought to study, and I hope the combined knowledge so obtained may bring about a more favourable state of things. Mr. Scott Russell's paper is one of those which lead a great many to think on the subject, and those who are led to think, will no doubt sooner or later take action.

Admiral RYDER: I should like to make a small contribution to this discussion. When I was employed as a naval *attaché* in France, I learned that in every cruising flag ship, there is a member of the Constructive Department of the French Navy, learning from actually seeing at sea how ships behave, his practical lesson of how to design ships. Why that is not done in our service, I have never been able to understand. I am perfectly confident of two things; that the young constructor would welcome most heartily the opportunity of going to sea, and I am perfectly confident the officers on board would welcome him most heartily there. As far as I know, however, at present there is no system by means of which the young constructor can attain any practical knowledge of our ships' behaviour at sea. After the loss of the "Captain," I asked one of the prominent members of the Constructive Department whether when they ascertained by testing that ship that her maximum angle of stability was of such an amount, that did not strike him as being very small, as it did all naval officers. His reply was very simple: "I did not attach importance to it; I have never been to sea; I have never been on a cruise in a ship." There is a very great moral in that remark, and I very much wish that I had any influence with the Admiralty which could induce them to take up the question, sending, as the French do, our young constructors to sea, making their promotion and advancement depend upon their having been to sea, and so learned their profession.

Admiral FISHBOURNE: I may state that that plan was carried out in the School of Naval Architecture established at Portsmouth. The plan had the double effect of teaching the officers on board the mathematical side of the question, and enabling the constructors to learn somewhat of the seafaring side of the question.

Colonel CARTER: Although I am a land-lubber, I take a great interest in this question. Our lecturer has given us to understand that he has a great deal more information to give us, and as this subject is so very important, and ought not to be hurriedly closed, I think it would be a great benefit to the service if, on some future occasion, he will continue his lecture upon this subject. There are some questions I should like to put myself, but I do not feel justified in doing so at this late hour of the evening; I will therefore respectfully suggest that Mr. Scott Russell should be asked to continue his lecture on a subsequent occasion.

Admiral FISHBOURNE: I am sure the Council will be glad to fall in with that suggestion, particularly if Mr. Scott Russell would complete his subject.

The CHAIRMAN: Before asking Mr. Scott Russell to reply to the questions put to him to-night, or to inform us when he will favour us with the completion of his paper—for we must all feel that it is a subject that may well be enlarged upon—I should like to offer a few remarks on the paper, and on some observations that have been made regarding it. I think, with reference to a remark by Admiral Selwyn, we are all opposed to useless ballast, and we may hope that all occasion for it has passed away. It has been, I will not say a custom, but an accident of the past in connection with ironclads, and I do not think you will find anyone connected with the ship-building department of the Admiralty who would advocate putting useless ballast into a ship. I must also

remark that it certainly is not the opinion of naval officers in general that our ships as now built are of such a dangerous form, or weighted in such a dangerous manner, that we should have any fear of going to sea in them in any circumstances whatever. My own opinion of them is, that our ironclads of the present day are, looking to all the services that may be required of them, the finest ships in the world. Admiral Selwyn asked whether it is not possible to build a ship that will right itself when she goes on her beam ends. Many of our ships will do so; I think Mr. White will perhaps bear me out in saying that some of them will go out to more than 100°, and right themselves. I do not mean ironclads, but troopships and others. Many of them would do so if you could insure that their upper works and hatchways were watertight. Our armour-clads and turret-ships would not go over so far with safety but they have such great stability that no sail that they carry, would ever bring them over on their beam ends. If we did not feel safe on that point I do not think any of us would care to go to sea, but I am satisfied I am speaking the opinion of a very large majority of naval officers, when I say that they have no hesitation or doubt in placing confidence in the sea-going qualities, and sea-worthiness of our ironclad ships.

I cannot sit down without expressing my admiration of the clear and lucid manner in which Mr. Scott Russell has explained to us the mystery—wave motion. I do not mean that he has brought forward any new theory, but his exposition has been so clear, that I think anyone who has heard it to-night will remember it as long as he lives. I should like very much to have the period and length of the “standard wave” clearly established, but it is a difficult matter to observe with accuracy, and no one has given the matter more study or conducted more experiments on the subject than Mr. Scott Russell. If officers in the Navy knew what careful instructions are issued by the Admiralty for observations on the length, periods, and height of waves, and on the rolling of ships, and also the admirable way in which it is explained how these observations are to be conducted, I think our naval architects would be overwhelmed with information on the subject, instead of getting it, as they do now, very rarely indeed. With reference to the remark of Admiral Ryder—I clearly understood that when the naval architects were established at Greenwich, it was quite settled that those young men were to go to sea to complete their training after they had passed their examination, and I do think Admiral Ryder’s suggestion ought to be most seriously considered, as it is one of great practical value.

MR. WHITE: Every student of naval architecture who enters the College is under an obligation to go to sea should the Admiralty decide to send him, but no orders on that subject have as yet been issued.

MR. SCOTT RUSSELL: I think I can answer at once the point which Mr. White put, namely, that I had not marked the change of metacentre. I knew that Mr. White would know in a moment when I put these points there (*pointing*) that in the act of doing so, the metacentric height was raised a proportional quantity. And if I had wanted to put the thing technically in shape, as between him and myself, I should have said, “Let us shift this metacentric height, and let us shift the centre of ballast down the corresponding and equivalent quantity, and then we shall by those two” means get the two elements of stability, and we shall get them exactly as equivalents of one another, and we shall get exactly the balance I am asking for.”

With regard to ships of war, I am obliged to say that the distribution of the weights of boilers and engines that I have sometimes seen, has been entirely contrary to the principle mentioned, of bringing them as near as possible to the centre of gravity of the ship, and as near as possible to the place where they would act as efficient ballast, and at the same time as weights in the place where they would produce least oscillation. I will not, however, criticise other people’s vessels, because it is not my duty, and I dislike it. I merely mean to say if I had not seen vessels in which all the great weights were utterly erroneously distributed with a view to these points, I should not have thought the observation worth making. I will just give one example. I do not like to mention it because it is a ship of my own building, but I remember having the question to settle, whether I would spread the boilers of a ship out in this manner at a certain distance, or whether I would put two boilers into one, and place them in the centre further down. I took the boilers out of the wings, and put them in the centre and put two boilers back to back; I thus got a good and low disposition of the weights, and made an excellent vessel without

any ballast. The engines and the screw ought to be regarded by the builder as weights, the disposition of which are entirely at the discretion of the designer, and I tell you why: there is no reason in the world why the shaft of a screw propeller should not have any angle you find it convenient to give it, and therefore I say to you in the most decided manner that all the bad dispositions I have seen of screw engines have been made through utter want of judgment and knowledge. You can put your engines wherever you please, which you could not do till we got the screw-propeller.

With regard to waves I have given you experiments occupying a large portion of ten years. My standard wave is based upon hundreds of perfectly exact experiments repeated over and over again, and those experiments which were made between 1834 and 1844 have not, so far as I know, ever been contradicted. I have not in this lecture touched on the subject of the manner in which waves interfere with and modify each other, which makes the observation a matter of extreme difficulty; I beg to say, however, that I shall search the volumes in which I can find any accurate wave experiments, and at our next meeting I shall be most happy to give you a summary of the results of these experiments, and I only hope that they will do what I want, give me my 3-14159 instead of the 3-57 which I am forced to adopt by nature herself pressing it on me.

With regard to what Admiral Selwyn said in regard to the inclinations of a ship, there are forms of ships which no possible derangement could ever turn upside-down; but at the same time I admit frankly that there are ships so constructed that if they were turned upside-down, they would have much greater stability than when they are downside-up, and those are dangerous ships, and ought to be avoided.

The Meeting was then adjourned to Monday, the 9th of June.

Monday, June 9, 1879.

Colonel CARTER: It is with some diffidence that I address an audience upon this subject, but if I have made an error of judgment, I hope you will excuse it. Mr. Scott Russell having evidently from want of time hurried his last lecture to a conclusion, I ventured to suggest from the extreme importance of the subject, which the sad fate of the turret ship the "Captain," had so indelibly impressed on every mind, that he should be invited to address us again. That suggestion was favourably entertained both by the audience and the lecturer, and we have now been favoured with Mr. Scott Russell's further observations, which we must all allow were particularly lucid and clear on that portion of the subject which is both difficult and complicated to discuss. I could not tell, of course, how he would further unfold and explain his subject, so it is consequent upon what I heard at the first lecture and the discussion which followed that I make the following observations. Mr. Scott Russell just had time to draw for us the sectional form he thought best for a stable ship, namely a circle with a pair of shoulders added, which, by adding width, gives stiffness, and showed us the place where ballast should permanently be, namely, at the bottom, but inside the circle, which gives stability. Mr. Scott Russell's idea, so lucidly conveyed, set me thinking, and the problem which had to be solved is what Admiral Selwyn very appropriately mentioned, namely, how can stability be given to ships which are so heavily weighted with massive iron turrets and monster guns on deck, and thick iron sides above watermark? The position that all these things of necessity occupy, renders a ship top heavy, and therefore easily capsized if it is not scientifically counteracted. Without such counteraction it would not require the furious raging of storm ocean waves to effect the capsize; but when a ship has to contend with the violence of fierce winds and rushing mountain waves it should possess all the means available for making her impossible to turn over. Now have our ships every available means to secure this end? I answer No, and in my opinion very far from it. When I first examined the beautiful model of the "Captain" which is in this Institution, I was no longer surprised that that vessel turned over.

My surprise was that she remained so long as she did upon the surface of the sea. And why do I state this? Because—I am afraid I am now going a little at variance with the theory Mr. Scott-Russell has put forward—because she was circular in form below, which offers no resistance whatever to the power of the wind and the wave; she had no keel, which does. I feel convinced that a keel to an iron turreted ship is essential to its safety, and to all ships, I should say, necessary to effect moderation and a lessening in rolling. When a ship with a keel rolls, the displacement of a large body of heavy water which a keel necessitates, would cause the rolling motion of the ship to be gentle and slow, whereby time would be obtained for the mountain wave to pass, and so the ship would roll back again on the opposite side of the wave before she could lurch over to a dangerous angle. To width of beam therefore, which tends, as Mr. Scott Russell has explained, to storm stability, I would also add, as an essential to the ship's safety, a keel. With such monstrously weighted decks as our men-of-war now have, I should not only have a keel, but a keel of a particular construction, that is to say, if such construction should not be found in practice different to what I conceive it probably would be. My theory is that the form of the keel should be such as to make the ship slow in rolling, and this advantage could be secured by making the keel gradually broader towards its base, but tapering towards the rudder as also the stem, so as not to interfere with the proper action of the water on the rudder or retard the ship's onward progress. As the ship rolls, the keel by this form would retard and lessen the momentum of the roll, and so would cause the ship to roll slowly and gently and not violently, which a high conical wave combined with a sudden gust of wind would effect, and with a dangerous momentum, without a keel. There would be an objection to this form if in practice it interferes with the buoyancy of the ship. I do not advocate, however, that the form should be carried to any excess, especially in a very deep keel. If the water below rises equally or nearly so with the water on the surface, the form would not interfere with the buoyancy of the ship; but if otherwise, I think that it would, but probably only slightly, even if the keel were a very deep one. A keel which broadens at its base may require practice to confirm its use, but a keel with perpendicular sides and heavily weighted, I believe to be absolutely essential to safety when ships are weighted on their decks with iron turrets and large guns. Mr. Scott Russell has condemned the "bilge" keels, but I fail to see that they are not a valuable addition to ensure slow rolling. They would, I suppose, cause the ship not to answer her helm so quickly as when without them, but this, if it be the case, is a consideration that is of comparative insignificance to stability, for stability is a quality that our men-of-war must possess over and above every other. I contend that a heavily weighted keel would form the best possible ballast, and would not usurp the room available for storage. I would illustrate this power of securing the greatest stability by bringing to your notice the principle of the steel bar. A steel bar has a long arm and a short arm. I place a weight A at the end of the short arm, and another weight nearly equidistant from the point of suspension C, which I call B, on the long side of the bar. Those weights, we will suppose, balance each other, but when I remove B further towards the extremity of the long arm to D, B will fall, say to the bottom, and A will correspondingly rise, that is to the top, immediately over B. This is exactly what we want our ships to do. Let A now, in its vertical position, represent our turrets and guns, B the keel of the ship, then the further we can have our heavy keel to counterbalance the turrets and guns on deck (which should be, as we can now see, as low as possible) the more effectual is such weight, so that when a ship rolls, which it always must, more or less, when it rides longitudinally over crescent waves, its natural position being at right angles to the surface of the water, B, the weighted keel would, by the law of gravitation, always be forcing the ship to assume a vertical position. A keel, therefore, such as I have indicated, would form the most effectual ballast, and would secure the greatest stability to the ship.

Admiral RYDER: I should like to ask one or two questions. Mr. Scott Russell has given us the length of the wave, the height of the wave, and the period of the wave; but do his researches enable him to give us the angle of the slope of the wave? When we were on the Committee of Designs some years ago, we sought that information, and were told by the scientific gentleman who advised us that the slope

of an ordinary sea wave never exceeded 4 deg., I noticed one of the great waves of translation which he speaks of, at Hakodadi, in Japan. There, everybody was full of an extraordinary wave that had reached them, though they did not know from whence, or anything about it; nor had any living man in his recollection seen a similar wave. It rose eight feet, and they congratulated themselves that it came at low water, instead of at high water spring tides, in which case it would certainly have drowned half the inhabitants. As it was, the top of the wave was only about two or three feet higher than the highest spring, and though it flooded their cellars, I do not believe anybody was drowned. They said there must have been an earthquake on the other side of the Pacific, and so it turned out. I suppose these waves that have their speed due to the depths, when they pass over different depths vary, and acquire a kind of mean speed.

Mr. SCOTT RUSSELL: Always; they go slower and faster.

Admiral SELWYN: I wish to ask Mr. Scott Russell to be good enough to tell us one or two things, and one is whether he has remarked at sea that on the calming down of the heavy sea arising from a gale of wind, the smaller waves gradually merge themselves into larger waves of longer period. Secondly, I would ask whether he considers it absolutely necessary that the bottom should shallow in order to produce the ground swell. I have been a good deal interested in the subject, and am specially interested in what Mr. Scott Russell has said to-night, because, although he gave us the year 1834 as one of the first instances, I have been making researches lately, and I am very much disposed to say that the first record we have of a big wave was in Noah's time, and that there were five deluges recurring after that. In the year 1822, not to go to other instances, the upheaval of the Chilian coast to the extent of eight feet, sent a wave of that character across to New Zealand, and in the submergence of Callao something of the same sort took place. In short, the more we look into the question of such great waves, of such rapid transmission, the more we see that they are principally caused by serious disturbance at the bottom of the ocean. At St. Helena there is a very curious form of wave, which comes in periodically, and in a measure at Ascension also. It is a series of big waves coming in for a day, setting in with awful fury, often in a perfect calm, without any sufficient cause whatever that we can see, and they are perfectly local. They generally set in from the eastward; we do not hear of any great disturbance having occurred, but these rollers set in at periodical times with devastating fury very much of the character of the ground swell of which Mr. Scott Russell has been speaking. I think the paper, both on the former occasion and on this, has very much advanced our mode of thinking of waves in general, and will lead to more close observation among the officers of the Service, as to the formation and courses of waves. As to myself, I am afraid I must still hold to a sort of affection which belonged to my youth with regard to the trochoidal wave in which the friction of the descending particles plays the greatest part in causing the breaker in sea waves. I dare say Mr. Scott Russell, in speaking of the circular movement of an atom of water, will allow that there is always a translation of that atom forwards in every case, combining the circular with the forward movement. With regard to the question of storm stability as distinguished from smooth-water stiffness, Mr. Scott Russell has done a great deal to show us what in his opinion would be the best form of vessel to combat what we all regret, the absence of real stability, although there is a great stiffness of platform in the modern contrivances which they call ships. But I am not satisfied with any of the modes which have yet been proposed for doing away with the difficulty. I see that we are still bound to heavy weights above and light bottoms in order to carry these heavy weights, and as, apparently, the heavy weights must be carried high up, I do not see how by any other contrivance than increasing the weights below, we can balance the weights above; but in doing so, unfortunately for ourselves, we incur the reproach of carrying more weight than we have any use for, and although yachtsmen show an enormous value for what they are pleased to term the "precious metal" in their keels, yet I doubt whether, added to the weights we are obliged to carry, a naval architect would like to be told to carry counterbalancing weights for no other purpose than that of counterbalancing the armour and the guns. Is there any other mode of getting rid of this difficulty? If we are to carry these weights very high up, what advantage does it give us, and why should we continue to do it? It is quite possible the Russians

may be right, and that the time for ironclads is gone, and that there are no more ironclads to be built. But the world does not think so at present, and I am disposed to think the failure of funds has more probably led to that conclusion than any other necessity. However that may be, it is quite clear as long as we have heavy guns and armour, we have to provide for heavy weights on board a floating structure. If we still insist on getting our speed in the floating structure by modern slopes of ten beams to a length, it appears impossible to get rid of the disadvantages of unstable equilibrium. I do not see any way out of it in that direction. If Mr. Scott Russell can give us any idea how we can get storm stability combined with smooth-water stiffness, I am sure we shall be happy to hear it, and I am quite sure if he does not know it he will very candidly say so, and tell us that on our present line there is no chance for our doing much in that direction. He will also, I have no doubt, at some future time, be ready to tell us something about how we can do it, and I hope that time will soon arrive.

Captain BURGESS: I do not know, Mr. Scott Russell, whether you ever saw a form of vessel introduced by Mr. Tovell, in which all the sections towards bow and stern were semi-circular. He had some vessels built for the Mediterranean trade, and he obtained some excellent results; but I do not think that the plan was ever generally introduced.

MR. SCOTT RUSSELL: One of my first vessels was built in that way.

The CHAIRMAN: I have myself observed several instances of waves such as Mr. Scott Russell described. I was once lying on the coast of Africa in perfectly smooth water with not a breath of air; the glass went down very much, so much that I felt it necessary to get steam up. I walked up and down for hours watching to see what was coming, as the glass continued to go down. Finally I saw a white line on the horizon. This was a solitary wave rolling in about six feet high above the natural level without a hollow in front. My bow was to the wave, I therefore had nothing to do except to steam ahead to keep the strain off the cable. It came along with great velocity. A schooner lay close to us broadside on. Her crew saw the wave coming, they lashed everything on deck, and then got in the rigging. It nearly capsized her; she made a dash at us, took away my quarter boat and stern boat, carrying away her bowsprit and fore topmast. There was only one wave that passed and broke on the beach. I felt sure that a storm had passed outside, and on examining some ships' logs, found that two vessels had been in a circular storm, and one was dismasted. In another case I saw an illustration of the transmutation of small waves after a storm into a ground swell. I was lying at anchor in Table Bay in three fathoms, with 75 fathoms of chain out, in perfectly calm weather; one of these solitary waves came in and took the vessel at such a rate astern as to cause a tremendous jerk as if it was tearing the bits out. I jumped up to see what was the matter but could see nothing. We went forward and the cable seemed to be all right. Concluding that something must have occurred, after supper we hove up and found the anchor shackle had broken. This is why Table Bay is so dangerous to vessels. This class of solitary wave comes and takes a vessel, brings her chain quite straight, and it breaks with the jerk. In another case in China, preceding a cyclone, the whole River Yang-tse-Kiang was unusually red, from the earth being stirred up by the coming storm, quite 48 hours before it arrived. I afterwards traced that cyclone to be 1,000 miles in diameter and to have been 2,000 miles away from us when this disturbance of the water and ground swell came up the Yang-tse-Kiang. Captain Maury's cousin, and other very accurate observers, were in this cyclone; I got their logs and mapped out its course. Mr. Scott Russell has given us a true explanation, and it is most important to recognise the distinction between the first and second order of waves; to confound these is to lose all judgment in the matter. To build ships with reference to one is to have them failing in the other; and to assume that because ships have been safe for a number of years in one class of wave, they will therefore be perfectly safe in another, is extremely unscientific and dangerous. There was some conflict on the last occasion between Mr. White's standard and Mr. Scott Russell's. The question is whether there has not been a confusion of waves as well as of their standards, whether there is not a standard for smooth-water waves and an entirely different standard for storm waves?

Admiral SELWYN: At St. Helena no ship dares to remain at anchor when one of these rollers comes in; if she does, her chains will not hold her, and such a wave with such a velocity of translation meeting a ship which has little initial stability either on quarter, bow or broadside, would be a most dangerous one for her.

Mr. SCOTT RUSSELL—in reply: Admiral Ryder asks me with regard to the slope of the wave. The slope of this wave is an extremely gentle one, but the trochoidal form absolutely remains. The trochoidal form is the result of the combination of the circular motion with the rectilinear motion. The propagation of the wave takes place equal distances in equal times, and the wave being propagated equal distances and in equal times, it is the circular motion that alters the slope of the wave. First of all, the slope of the wave is extremely gentle. I cannot say how small the angle is until it becomes a storm wave, and then the angle certainly gets up to 60°. The storm wave is a sudden elevation of the wave up to double its former height; that always takes place both in the ground swell and in the other. A remarkable thing in the ground swell is this. If you see the ground swell regularly breaking with the waves 20 feet high, you may be quite sure that the water there is a little more than 20 feet deep, and always when this ground swell comes to a height equal to its depth it assumes a position of tottering equilibrium before it gets to the maximum, so that the depth will always be greater than the water appears to be when judged by the height at the top. In like manner with regard to the breaking of the surface wave, apart from all rule of course, the wind will pitch it over and break it, but if you can imagine a surface wave breaking merely by its own gentle curve you will find the storm wave breaks whenever its height becomes equal to about one-fourth of its length. I have never seen one of them able to rise to a greater height than that. The sharpest wave I have ever seen on the surface of the water is a wave of which the height is one-fourth of the length. In regard to the ground swell and the wave of translation the length is very great, but at the same time I have seen them culminating in a smaller height in the act of breaking to that of the ordinary surface storm wave. With regard to Admiral Selwyn's question, I may say I think the ground swell would break by mere accumulation. Supposing an island to rise very slowly, the result will be a very long low wave, and whenever this wave comes into a good deal shallower water the shortening of the wave must increase the height and therefore the long earthquake wave may, by sudden shortening, become a breaker. Tides become breakers; when they come up a shallow river they become bores; although they are very long, still the crest becomes a breaker from, as I think, this shortening of the wave. Supposing a storm to have existed with the surface waves, then the surface waves as long as they continue storm waves, will break, and supposing a second wave of much smaller size goes over the surface wave, it breaks, and therefore I say a great continuation of storm surface waves would break on the top of each other, whenever their crests coincide, and would gradually in that way settle down and be used up.

With regard to the very difficult problem which the Admiral has put to me as to carrying weights high up, without carrying useless weights low down, there is only one solution, and that I think I mentioned formerly. It is to begin with the resolution that we will not carry any useless weights at any cost. Then put as much weight as you think desirable for strength into the bottom of your ship, and so design your engine and boilers that all available and useful weights shall be placed at such a depth as to assist in giving the stability that you want. It really comes to this, that you will keep those top weights of yours as low down as you can, and you really come back to the conclusion that heavy armour high up is unwise, inexpedient, and makes an unseaworthy ship. I advocate keeping the armour low down, not putting tall turrets up into the air, but arming a ship of war with a particular kind of gun kept low down as near the water line as convenient, and in that way making her a good seaworthy ship. I remain of opinion that you ought to consider a ship of war as having this essential point in her, that first she must be a seaworthy ship; and having done that, I think you can make her a perfectly seaworthy ship at the same time that you give her all the protection she wants. What is practice in life but this? Take the inevitable conditions and make the best of them you can. Therefore when a problem of building a ship is given you, and you have given her the right size and shape, and put your weights and your boilers in the right place, and

have kept your guns and armour as low down as you can, you have done all that is possible.

With regard to the question of keel, I would simply say this,—that very often we have no choice. When we build a yacht we are allowed to put the keel as low down as we please, but when we come to build a ship of war, we dare not put an inch of keel on, because of the draught of water. But I will call attention to the fact that the bow of the ship is practically keel and nothing else; it is a sharp wedge and prevents rolling. With regard to the oscillations of a ship, I would also call attention to this, that a ship has no tendency to oscillate. Nothing can cause it to do so, excepting either the wind above, or the action of the sea upon its keels. Therefore it is that I do not like these bilge keels, because they are just the thing which enables the wave to compel the ship to oscillate. The only reason why we do not use keels is, that we must give these enormous ships a limited draught of water. What we must do, is to build the ship of such a form, and put her weights in such a manner that she shall not of herself have any tendency to roll. That is why I begin with the circular form, and with that circular form the ship does not roll. With regard to Mr. White's standard, I think the matter is very simple. In the former lecture I gave this series of waves, and in this series there was a wave which I gave as the standard 3·57. That wave was the result of 10 years' observation, and you find hundreds of those waves in the reports of the British Association, all of them showing this particular dimension as the one standard. Until, therefore, another set of experiments of equal value has been made, establishing some other standard, I think we must keep to that as the old standard. I think that what perhaps misled him was, that he thought I was speaking of the deep-sea waves instead of the surface waves, and if he had been here to-night, I could have presented him with a standard wave, which would be exactly the wave he wanted. There was a wave of 5·67 in this class, and the wave of 3·57 remains to please me in the other class.

Admiral RYDER: Have the experiments been as extensive for that wave as for the other?

Mr. SCOTT RUSSELL: As extensive, and on a much larger scale. The first considerable report was in 1837, and the remainder of the reports were made in 1844.

The CHAIRMAN: I am sure you will allow me to return your thanks to Mr. Scott Russell for his very interesting paper.

NAMES OF MEMBERS who joined the Institution between the 1st July and the 30th September, 1879.

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Tyler, Henry E., Lieut. R.E.	McCallum, H. E., Lieut. R.E.
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Farren, R. T., C.B., Lieut.-General, Colonel 35th Regiment.	Woolcombe, H. B., Captain R.N.
Carter, F. W., Major Duke of Edinburgh's Artillery Militia.	Whelan, F. A., Lieut. R.M.L.I.
Stokes, Sir John, K.C.B., Colonel R.E.	Carden, Henry C., Lieut. 11th Regiment.
Fordeyce, Alex. D., Captain Duke of Edinburgh's Artillery Militia.	Thompson, Ross, Lieut. 11th Regiment.
	Yarde-Buller, Hon. Walter, Lieut. 11th Regiment.

OCCASIONAL PAPERS AND NOTICES OF BOOKS.

This portion of the Number is reserved for Articles, either Original or Compiled, on Professional Subjects connected with Foreign Naval and Military matters; also for Notices of Professional Books, either Foreign or English.

It is requested that communications or books for review may be addressed, during the temporary absence of Lieut.-Colonel Lonsdale Hale, to

COLONEL SIR LUMLEY GRAHAM, BART.,

Royal United Service Institution,

Whitehall Yard, London, S.W.

ON THE ORGANIZATION OF THE AUXILIARY SERVICES IN A BESIEGED FORTRESS, AND THE MEASURES TO BE TAKEN TO PROVIDE AND CARE FOR THE TROOPS OF THE DEFENCE.

Abridged by Captain J. GORE BOOTH, R.E.

From the Work of Von Kamptz, Major-General Prussian Service;
and an Analysis of the above by J. Bornecque, Capitaine 3me Régiment du Génie.

I.

A QUESTION little enough familiarized in the English Army is incontestably that which treats of the *rôle* of the three arms in the attack and defence of a fortress, but especially so in the latter. Now, at the present time, more than ever, this question is of considerable importance to all Officers in the Army. It is advantageous, therefore, that with Officers and men there should exist, in default of precise rules, directions as detailed as possible as to the dispositions to make in the different cases which may occur, and for the different *rôles* that the defenders of all ranks may be called on to fill.

The German Major-General Von Kamptz has applied himself to the study for a long time, under all its aspects and with incontestable ability, of the different questions bearing on the organization of the various services in besieged places.¹

¹ General Von Kamptz belongs to the Artillery, and left the service in 1835. He has published among other works "The Service of the Infantry in the Defence against an Attack in Force," and "The Service of Supply in the Defence of Places."

To give an idea of this work, which has no counterpart in England we believe, and in order to give most useful, practical hints, we propose to analyze the last work of this General, a work whose title is "The Organization of the Auxiliary Services in a Besieged Fortress," and the Measures to be taken to provide and care for the Troops of "the Defence;" and of which the second part appeared in 1877.

The author always accompanies his assertions by historical examples; but it will be understood that in this analysis, necessarily abridged, we shall only cite the most conclusive examples, and those in a summary manner.

We think we ought to reproduce, in its integrity, the introduction, as it shows the aim that the author proposes to himself, and the manner in which the question is treated.

In a work published in 1855 the author has endeavoured to prove that there must always be a numerous garrison to guard the various works of a fortress.

Assuredly in occupying as advanced posts positions favourably situated in front of the works, the advantage will be secured of being able to reduce considerably the service of guards in the works: in certain cases one may indeed be satisfied with a mere observation which naturally requires but few men. One will confine oneself by preference to guarding approaches (gates, posterns, dams, &c.) and detached works. It will suffice to place some sentries in the other parts of the works and to hold the reserves in their quarters.

This procedure allows of the troops being eased to a certain extent, which is not to be despised.

But in practice things happen differently. A simple service of observation in the works of a fortress placed in a state of defence, is only admissible when it is in a state of complete security, when the enemy is still far distant and has not the power of appearing suddenly within the sphere of action of the place, by making use of the rapid means of transport of our time (railways, steamboats, &c.); or, indeed, when the troops of the place are so well drilled and instructed that they can at once move on the threatened works.

But if the enemy has rapid means of transport, if he can in twenty-four hours appear before the fortress, if the garrison is not formed, if it has only arrived a short time previously, or if it has been in great part employed on the works of arming, which is the common case, the time which is to spare after the completion of these works until the arrival of the enemy will be assuredly devoted to drilling all the detachments of the garrison, in guarding the works, and in the services of the defence.

And these indispensable drills will absorb the short space of time which will accrue from the completion of the defensive measures until the enemy appears before the place.

These considerations apply rigorously to all frontier fortresses.

And since railways and steamboats have given such great facilities as regards rapid transport, since each State has reduced to a minimum the number of its fortresses of the interior, one arrives at the conclusion that every fortress must be considered as a frontier one.

Thus it is sufficiently demonstrated that the guarding of a fortress, such as the author understands in his work published in 1855, is the rule, and simple observation is an exception, which ought only to be incidentally admitted in fortresses in the interior.

But he who knows the rule will well understand, in cases of exception, how to carry on, if to knowledge of his profession he unites judgment and resolution. One has a right to expect these qualities in each superior Officer to whom is entrusted the defence of a place, and who alone decides on the employment of the troops.

To wish to reduce the guard of the works to a mere observation is only trying to ease the troops of the garrison and without imperative necessity; it is to wish, without justifiable excuse, to compromise the security of the place.

In a fortress, it is not in the service of the guard and defence that one ought to ease the troops, as an old military maxim, well borne out by experience, says: "The heavier the work the greater the glory." It is not then by reducing the duties under arms or in easing them that one must attempt to lighten the work of the troops.

But, then, how to attain this object, and how to leave the garrison of a fortress always disposable and ready for fighting? Such is the question that presents itself, and the solution of which is in the following pages.

And to begin with, we propound this first principle: the combatants ought to be relieved from all works which can be as well executed by civilians.

Then care ought to be taken that the soldiers off duty can rest quietly and in complete security, that the combatants receive substantial and abundant nourishment, clothing suited to the season, and lastly, that the sick and wounded are taken the greatest possible care of.

In the first place we will examine the different works of defence, to discover of which we can and ought to relieve the combatants; we will investigate later on how we should assure the repose of the men not on duty; we will speak of the care to be given to the sick and wounded, and we will consider the food and clothing of the soldier.

Lastly, we will speak of the organization of the other services which have more or less importance in the defence of a place.

II. *Organization of the Works in a Fortress prepared for Defence.*

The author divides these works into three heads. The first comprises those executed under fire, and which in consequence endanger life. These should be executed exclusively by the combatants.

They consist of shelters of all kinds, of the repair of parts of the fortress demolished by the enemy's fire, of the emplacement of new pieces, the construction of counter-approaches, of mines, the preparation and transport of ammunition during the defence, &c.

The greater part of these works falls to the artillery and engineers; but these alone cannot fulfil this task, and the infantry has always assisted in considerable numbers. Military history teaches us that the best defences have been made where the men understood not only the

use of their arms but also of pick and shovel. To the second head belong those works which in themselves present no danger, but which being executed under fire, more or less direct, of the enemy, sometimes imperil the lives of the workmen.

Under this head are—

1. *The Transport of the Wounded.*—As a matter of fact, here, as well as on the field of battle, the transport of the wounded furnishes to those who do not wish to do their duty, the occasion so wished for, of withdrawing from the combat. This service in all cases diminishes the number of combatants: nay, more, it is important that it should be done by skilled men. This is why it is indispensable to create in each besieged fortress a company of sick bearers, who, divided amongst the ambulances, hold themselves ready to act during the fight. These ambulances should be established in safe places in the neighbourhood of the front of attack, in each detached work, and in the larger out-works.

It may be seen elsewhere in military history that in all celebrated sieges the combatants have not been charged with the transport of the wounded from the theatre of action.

2. The supply of ammunition for the ordnance, and of all means of fighting arranged for the defence.

3. The exchange and repair of pieces of ordnance, of machines, of engines put *hors de combat* or become useless, of material for the construction of batteries, &c.

4. The transport of ordnance, engines, and of *matériel* from the parks and *dépôt* of artillery to the ramparts, forming part of the duties of the *personnel* of the garrison artillery already organized militarily in time of peace.

In a work published in 1862 the author gives all the necessary instructions, not only for the supply of ammunition but also for all that affects Nos. 3 and 4 services.

The supply of ammunition to the ordnance necessitates an immense amount of work even in small places. If, indeed, auxiliaries for this supply only had to be furnished, it might be admitted, strictly speaking, that the active troops in the garrison should accomplish this work with the aid of some teams; but to this increase of work must further be added the replacing guns, engines, machines, and utensils which are unserviceable, and the emplacement of new guns and engines to increase the fighting power of the defence.

It is then evident that the active troops of the garrison ought not to be worn out by such heavy work, having no immediate connection with the armed defence, and that they ought not to be taken away from their active duties.

From this, it is concluded that the service of bringing up ammunition, guns and engines, machines and *matériel* of construction from the different *dépôts* to the rampart, should be performed by a company of artificers of the *dépôt*, organized militarily, and to whose aid active troops off duty will only be called in, in exceptional cases.

The following shows how the author understands the composition of this company of auxiliaries to the artillery. During peace time it

is very advantageous to have a certain number of permanent workmen (10 to 25) in fortified places, where it is easy to employ them, who relieve the troops of the garrison from this kind of work during peace, thus allowing the military instruction of the troops to be carried on uninterruptedly.

In the arming of the fortress this cadre will be of great use, on account of their being accustomed to handle war material, because of their knowing all the shelters, all the communications of the place, and the emplacement of all the ordnance of the defence.

This cadre is formed of men who have terminated their service in the active army. They would be, so to speak, workmen.

As soon as the arming of the fortress is commenced, this company is raised to war strength by enrolling the inhabitants of the town and environs, who gain their living as porters, navvies, commissionaires, &c. In this manner, during the siege of a fortress, the existence of this class of inhabitants is assured, and they are placed under military discipline, two reasons which prevent them from giving themselves up to intrigue, which might prove hurtful to the defence of the place.

At the same time that the workmen are being organized, the services of vehicles, &c., must be impressed to carry the ammunition, engines, machines, material for construction, &c.

During the arming of the place the waggons of the field-pieces destined for sorties cannot be counted on, also civilian waggons ought only to be employed for transport necessitated by the arming; these waggons ought to be grouped in stations, called transport stations, under the direction and control of the military.

If, at the head of the civil transport, one cannot find a contractor having sufficient authority for commander, it will be necessary to confide this service to two active non-commissioned officers of artillery. The one as postmaster should have to see that the full waggons arrive at the proper times and places, and that horses and conductors are always available. The other, as baggage-master, should have to keep always in perfect order the means of transport requisitioned from the inhabitants, to reject those which are defective, and to appropriate the carriages to the kind of material they ought to carry. The postmaster and baggage-master are aided in their work by police agents told off to this effect.

The horses and conductors of the contractors who in peace do the transport work for the artillery and engineers of the place should be used in addition, and contracts should be concluded with them with the view of furnishing transport for the defence in case of war. If the transport can be carried on by water or rail, the direction falls on the engineers.

It must be admitted, in principle, that artillery Officers should not be put at the head of the three services enumerated above, for the number of these Officers is much restricted, and their presence is much more necessary elsewhere.

5. *Service of Powder Magazines in the Fortress.*—This service comprises all the magazines and shelters for made-up ammunition and loaded projectiles, as well as magazines for the manipulation of ex-

plosives. The administration of these magazines in the defence of places belongs specially to the *personnel* of the artillery artificers, who ordinarily have among their duties the magazines of powder for peace supply, who understand the distribution of the ammunition, the manner of issue, and have charge of the accounts of these magazines. To the *personnel* placed at the disposal of the head of this department are added, for the manipulation and distribution of barrels of powder and boxes of cartridges, steady men of the *depôt* artificer company, already accustomed to this dangerous manipulation, and who are never called to other duties, so as to be always available for this service.

6. *Manipulation of Powder in the Laboratories.*—The manipulation of powder in the different laboratories, and in the places told off for this purpose, is under the direction and superintendence of the *personnel* of the artificers. The men who work there should receive special instruction, and be permanent auxiliaries. They form the section of artificers of the *depôt* company of workmen, and in war time, there are added to them the inhabitants who have already served in the artillery corps, and who have been employed in the making of chemicals, or of explosives.

7. *Extinction of Fire in a Fortress.*—Historical facts teach us that in a besieged place the extinction of fires must be left to the inhabitants. If the organization of the means for combating fires is given to the engineers, and if this service is placed under the superintendence of a superior Officer, the activity of civil firemen may be relied on in the moment of danger. In addition to this there is already in most fortresses a corps of firemen well organized.

Naturally, from the moment of the declaration of the state of siege, the entire direction of the corps of firemen belongs to the Governor. To assure completely the concurrence of the inhabitants, who form part of the corps of firemen, it is necessary to grant them certain privileges, for instance, to exempt them from billeting soldiers, to give them pay or victuals each time they are employed, &c.

In addition, care must be taken that each house is provided with water, that posts of firemen are established in the different quarters of the town, that the principal posts are sufficiently numerous. These posts have, above all, the duty of signalling the points where fires may break out, by means of telegraphs laid down for this purpose.

The fire brigade should during a bombardment send constant patrols into the streets. The patrol should immediately enter the house into which a shell may have fallen, to extinguish at once the fire lit by the projectile, to extract from wood-work by means of pincers of iron and hatchets any light balls, and to throw them into casks or buckets full of water placed in readiness in each building.

8. *Organization of the Manufacture of Gunpowder and Gun-cotton.*—Although the quantity of powder and gun-cotton may have been calculated on a very large scale; even if all the requirements to neutralize the explosion of magazines have been fulfilled, yet circumstances may happen to upset all precautions taken, and cause great loss of powder; endeavours will, of course, be made to lessen these losses by utilizing the powder found in the town at the shops

of merchants and private individuals, but the quantity thus procurable will never be sufficient to compensate for losses resulting from the explosion of even a single powder magazine.

Also at the very latest, on the declaration of the state of siege, and in all cases before the enemy appears in force before the place, emplacements should be prepared, materials collected, and workmen engaged, to manufacture gunpowder or to prepare guncotton.

However small the quantity of gunpowder made relatively to the large consumption of it in a besieged place, there should be no hesitation in organizing this manufacture. In effect, military history cites numerous examples of the decisive influence that the prolongation of its defence for a day only may have on the fate of a place. As for bringing powder into a besieged place, one cannot dream of it. The success of such an enterprise should only be considered as a happy chance, and quite exceptional. In any case this could only be done in small quantities.

In large towns, the manufacture of gunpowder is always possible, because they have less fear from bombardment, the materials necessary are more easily found there, and there is a greater choice of *personnel* fit for this service from whom to recruit.

But if this manufacture cannot give a supply equal to the demand, care should be taken, on seeing that the powder may fail, to reserve it for loading guns and firearms, using guncotton for mines and explosions. The preparation of guncotton is possible even in the smallest places; every chemist can manufacture it.

To sum up, as regards the works in the second category, the author expresses himself as follows:—

“The examination of this second category of works, from which the active troops should be relieved, leads us to the organization—

- “1. Of a company of sick bearers.
 - “2. Of a *depôt* company of workmen with their transport.
 - “3. Of a *personnel* of artificer workmen with a section of manipulators.
 - “4. Of a fire brigade (civil) with its carriages.
 - “5. Of a service for the manufacture of gunpowder and guncotton.
- “It will be objected, perhaps, that the organization of this auxiliary corps imposes too considerable an obligation on the town and environs; but one should reflect that in every defence all resources should be utilized with the greatest energy as well as all forces at disposal, if success is really desired, and a victorious end to the struggle. All half measures, all weakness, are here fatal. Then even if success appears doubtful, he will be insane who does not do everything to assure victory; for in all cases it can never do harm to have used all one's efforts. Besides, such an organization, far from imposing too heavy a charge on the inhabitants, on the contrary only procures advantages, since it assures to the poorest part of the population subsistence and profit during the rigours of a siege, and prevents their being sent away. And this creation of auxiliary workmen relieves the active troops enormously, and renders them always available.

" Besides the moral effect that the organization of the auxiliary workmen should exercise on all is not to be despised. Each defender will have faith in success if he sees the defence of the fortress well prepared. This organization is then a means of interesting the garrison and inhabitants in the defence, and of giving a greater amount of energy to the defence.

" But it is indispensable to prepare in peace time this organization of auxiliary corps, by forming the cadre of the company of workmen of the depôt, of the *personnel* of the artificer workmen of the section of manipulators, by increasing the fire brigade belonging to the town, so as not to lose too much time in their formation.

" By the rapidity with which the auxiliary corps enter into action, which proves at the same time the care with which the defence has been prepared, the courage of the defenders is raised and all the difficulties are prevented which the sudden apparition of the enemy before the place might create, in hindering the inhabitants of the environs useful for the defence, from entering the place."

We now pass to the third category. This comprises all the works which in a besieged town can be executed without any danger.

We will examine first what nearly concerns the soldier.

1. *Preparation of Food.*—To increase the number of men disposable for the service, the author proposes to cause the food to be prepared by women of a certain age, and fulfilling certain conditions of capacity, honesty, and morality. In this way besides the cooking will be better done than by men, who in general have scarcely any aptitude for this kind of service; moreover, the means of subsistence are given to a certain number of females who would perhaps be deprived of it without this.

This combination appears to be rather doubtful, the economy in men would not be so great, and would not compensate for the inconvenience of having women in quarters. Lastly, it would increase expense. It is essential to give each man coffee in the morning, and two good meals as varied as possible per diem. It is well known how the physical affects the moral.

2. *Washing, Patching, and Darning Body Linen.*—For the same reason as above, the author demands that the soldier in a besieged place shall be relieved of the care of washing and repairing his linen, and abandons to women these works essentially feminine.

This is generally the case in the English service.

3. *Repairs of Clothing and Boots.*—In peace time the necessary workmen to execute necessary repairs to clothing and boots are chosen amongst the men, according as their previous trades are tailors or shoemakers. In a besieged fortress, so as not to take away from the defence, the workmen who have been trained to arms, or to make up for insufficiency of the latter, the town's work-people can be enrolled and treated militarily.

4. *Workshops for Repair of War Material.*—The repairs to war material in a besieged place are done at the workshops of armourers, and by those of the artillery.

In war time, all the armourers belonging to the troops are sent to

the workshops in question, and when there are not enough of these, even civil armourers and mechanics.

The author gives the detail of artificers necessary for the repair of war materials in a bastioned fortress; on a hexagon, according to him there are necessary, 6 armourers, 9 blacksmiths, 4 locksmiths, 6 wheelwrights, 2 joiners, 1 turner in wood, 2 turners in metal, 2 saddlers, and 13 carpenters; about a total of 44 workmen.

If in so small a place as a hexagon there are necessary 44 men for the workshops, it is easy to imagine the increased number of workmen that will be necessary in a large fortress, where double or triple will be required. Therefore even in small places the garrisons must not be weakened, except under the most urgent necessity, by the number of workmen necessary, especially as the town almost always possesses workmen of the trades required.

The Officers of the artillery artificers have, in addition during a siege, the control and direction of repairs to war material the same as in peace time.

5. *Service of the Artillery Arsenal in a Place in a State of Defence.*—This in a fortress is one that demands the greatest activity and self-denial, and which, however, never gives to those in charge the opportunity of displaying their brilliant qualities.

The duties of the artillery arsenal during a state of siege are divided into six sections.

Section I. Charge of books and money, reports on arms, ammunition, materials for construction, the *personnel*, &c. The composition may be, 1 Officer, 2 non-commissioned officers, and 4 men.

Section II. Supply to the active troops, of ammunition, arms, material, &c. For this service there must be detailed 2 Officers, 8 non-commissioned officers, and 120 men of the company of workmen of the *dépôt* as permanent aids.

Section III. Superintendence and issue of powder, ammunition, explosives, inflammables, and loaded shells.

The *personnel* necessary—

1st. For the main magazine, 1 Officer of artillery, and 4 workmen of the *dépôt*.

2nd. For the magazine for daily issue, 1 Officer of artillery, and 1 non-commissioned officer of artillery, 4 auxiliaries of the workmen of the *dépôt*.

3rd. For the magazines of explosives and inflammable bodies, 1 non-commissioned officer of artillery, and 2 workmen of the *dépôt* per front of attack, or for all the fronts of detached works.

4th. For each large expense magazine, where are deposited loaded shells, 1 non-commissioned officer of artillery, and 2 workmen.

Section IV. Manipulation. For this service are required—

1st. In the principal laboratory, 1 Officer artificer, 5 artificers, and 15 men.

2nd. In each separate laboratory, 1 chief artificer, 2 artificers, 6 workmen of the *dépôt*.

Section V. For the administration and accounts of the park for projectiles, for that for tools, that of material for the construction of

batteries, that of wood prepared (axletrees, naves, &c.), and those of materials for working the ammunition, there must be reckoned: 4 non-commissioned officers artillery, and 8 workmen of the dépôt.

Section VI. For the administration and accounts of the park for guns, gun carriages, wheels, and spare shafts; and of portable arms (wall pieces, movable and spare breech pieces for guns), are reckoned: 6 non-commissioned officers artillery, and 14 workmen of the dépôt.

6. *Organization of Engineer Services in a Fortress.*—The works of defence which belong to the engineers are divided according to their nature into three categories.

The first category comprises the closing of all communications, the complete obstruction of useless passages, the barring rivers or canals which flow through the place or adjoin it, lastly, the organization of water manœuvres in the ditches, the inundation of low-lying ground and marshes situated around the place, so as to render the work of the attack impossible on this ground.

The second category concerns the works for placing the fortress in a state of defence, among which we may cite first, the palisading to increase the strength of the works, or to place them beyond the power of an attack in force. In the second place, the ground in front of the fortress should be levelled, reconnoitred, and cleared, so as to hide the works from view.

Lastly, the third category comprises all the works destined to shelter the troops and war material in the works of the fortress, the earth-works necessary to cover with earth the magazines, buildings placed in a state of defence, the guard-houses, the construction of blockhouses, the establishment of blindages open at the sides (*hangars*), &c.

All the materials necessary for the execution of these works should have been prepared in peace time with the greatest care, so as to be able to execute them without loss of time at the moment of need.

Also during peace time the commanding engineer should make a detailed plan for putting the fortress in a state of defence, to determine definitively the points on which to work, to calculate the materials necessary for each kind of work, the number of workmen required for each place, lastly, to calculate the time in which each work can be done.

This is how the author sketches the rôle of the commanding engineer during the defence.

The active service of the commanding engineer embraces above all four essential points.

a. *Daily Reconnaissances.*—Generally they present some danger. From the enemy's establishment, his preparations and his first works must be gained the indications for directing the works of the fortress, for opposing as much as possible the besiegers' enterprises, for rendering them abortive or excessively perilous.

It is the duty of the commanding engineer to discover which is the front of attack chosen by the enemy, which is the day on which he opens the first parallel, to foresee the works that the besiegers can undertake during the night.

The daily reconnaissances of the Officers commanding the artillery of the place are not less perilous, but they are more restricted. They are, above all, to determine the emplacement for guns, to order the establishment of new batteries, and fix on the positions of the artillery-men by day and night.

b. The Organization of Counter-approaches.—This powerful means of active defence can only be employed, with a chance of success, when used judiciously and opportunely, in profiting by the faults of the enemy.

c. The Employment of Counter-mines.—Numerous historical examples show the importance of the employment of this kind of defence, when well understood.

d. Water Manœuvres and Inundations.—It is the duty of the commanding engineer to bring into play, at opportune moments, the sluices placed in the ditches of the fortress for water manœuvres are a powerful aid to prolonging the defence, when used at proper times.

For inundations we refer to a work of the author, published in 1855, called, "Service of the Infantry in Defence of Fortified Places against an Attack in Force."

From the glance that we have just given at the functions of the commanding engineer, it will be seen that he has, in a fortress, the principal direction of the services of the fortification, and of the works that the engineers should execute. The number of his functions, and the importance of each of them, necessitate the attaching to him a certain number of engineer Officers to conduct the details and to give him secretaries and draughtsmen.

In large fortresses the staff of the commanding engineer should be composed of 5 Officers of engineers, 5 assistants (*wallmeister*) of engineers, 2 or 3 draughtsmen, 4 or 5 secretaries, 2 orderlies.

The five engineer Officers and assistants are the natural aides of the commanding engineer in the different services. Each of them should be given permanent charge of a special branch.

As for the other engineer Officers, who are told off for service in the different works—1 engineer Officer and assistants for reconnoitring the attack and laying out works of defence; 1 engineer Officer and assistants for mines; 1 engineer Officer and assistants for water manœuvres; 1 engineer Officer and assistants for repairing works in the fortress; 1 engineer Officer and assistants for counter-approaches, sorties and adjutant—they remain under the orders of the commander of the sector to which they belong; their number is determined from the size and importance of the enceinte of the place and the detached works.

Basing on what we have just said, the engineer service in a besieged place may be divided into 7 sections.

1st section. Registers and payments, preparations of reports of the state of places, correspondence and designs of projects, 6 secretaries or military draughtsmen, 1 civil clerk.

2nd section. Service of the *matériel*, of the tools and implements; the supplies, &c., for construction and transport; 1 secretary, 18 to 20 men, superintendents or workmen.

3rd section (eventually). Service of the *matériel*, of machines, of tools, &c., required for working the inundation; 1 secretary, 2 watchmen, 2 superintendents, 26 sluice openers, &c.

4th section. Service of boats, of stockades and of ice (to break the ice in case of frost); 1 pilot and 2 oarsmen per boat, 1 pilot, 1 mechanic, 2 stokers, 2 sailors per steam-boat.

5th section. Service of tools, *matériel*, and engines for mines, 1 watchman, 4 miners, 2 carpenters.

6th section. Service of roads, charged with looking after all roads, passages, and bridges; 1 secretary, 2 guards, 2 superintendents, 1 chief pontoonier, 4 carpenters, 30 to 40 men.

On these works part of the civil prisoners or prisoners of war may be employed.

7th section. Service of transport of *matériel* for construction, of tools for trades or earthworks, of various engineer-magazines of the enceinte or detached works; 1 secretary, 2 guards, 2 chief packers, 30 men, as in 6th section.

From this summary glance at the various duties of the engineer service, and of the *personnel* for the execution of them, it follows that it is necessary in war time, not only to take secretaries and guards from the reserve and auxiliary forces, but, in addition, to organize a special company of auxiliary engineer workmen, whose non-commissioned officers will serve as superintendents, as quartermasters, as guards of the dams, as pilots, as mechanics, as miners, &c.

As in fortresses in peace time works are going on unceasingly, there cannot fail to be in the town or environs men capable of making superintendents, or of executing those works, and who will be disposed in war time to gain their livelihood by working on the fortifications. Besides, in a number of circumstances, civil prisoners and prisoners of war may be advantageously employed. It is, besides, only justice that the inhabitants who form part of the auxiliary company of engineers, should be relieved of certain parts of the work, on account of the danger to which they are exposed.

If, then, the *personnel* of the workmen is recruited in this way, the active troops of all arms will be considerably relieved. Part of the inhabitants will be employed on remunerative work, and will have every interest in seeing the defence prolonged.

To recapitulate, for this third category of works, it is necessary, in order to relieve the active troops, to organize in a fortress—

1. An auxiliary company of engineers.

2. Workshops to repair war *matériel*.

3. Cooking places, washhouses, workshops for making and repairing clothing and boots.

While making all possible arrangements, it must not be forgotten to try to ameliorate the lot of the active troops, by procuring for them the greatest amount of comfort possible in all cases.

III. *The Barrack Accommodation of the Soldier.*

The author takes up the cudgels against writers who, without any reflection, divide the garrison of a besieged place into three equal

parts, corresponding, say they, to the three states of a soldier in the defence (duty under arms, fatigue duty, repose), because this way of looking at it spreads the false notion that, in a fortress, it is sufficient to have just enough shelter from mortar fire to place in safety the third part of the garrison that is off duty.

It must be observed, with reason, that the duty on fatigue cannot last twenty-four hours without interruption, that certain works can only be executed at certain moments, that one of the three sections of the garrison cannot be always required, whether for duty under arms, or on fatigue, &c.

He concludes that, in order to satisfy the most moderate exigencies, it is necessary that the soldier who devotes his person and life to the defence, should find in the fortress a lodging which would place him under shelter from weather and projectiles. He adds that it is not astonishing that, where these conditions are not fulfilled, the troops soon come to the end of their physical strength, and that soon, also, they will have lost all their moral force.

Besides, it is indispensable to arrange, as far as possible, that the same man will always have the same place:—1st. So as not to fatigue the soldier uselessly; 2nd. Not to expose two men to meet each other in the same lodging, to occupy the same place; 3rd. To enable better hygienic care to be observed, as also the cleanliness of the barracks; 4th. To facilitate the control; 5th. To prevent the development of contagious diseases.

Let us examine the different kinds of shelter that can be provided for the soldier returning from service under arms or from the works, quite tired and over-excited by the dangers he has just been through. In the first place, there are in fortresses bombproof casemates, then barracks and private houses are used; lastly, the troops may be under canvas or in wooden huts.

The Casemates.—These are divided according to their use, into defensive casemates, those for living in, and those for magazines. We will here speak in general of the casemates for living in.

Unfortunately it is but rarely that, in all the works of a strong place, the number of bombproof casemates is sufficient for the lodgment of the troops, in view of the defence of these works, and it would be urgently requisite to provide for their insufficiency. But besides, in peace time, the dwelling casemates are generally used as magazines, so that at the moment of their being put to their proper use, these casemates are infested with the germs of dry rot or with bad smells. It even happens, that, whatever may be done, it is not possible to make the casemates healthy; this then engenders sickness, the general consequence of which is to render this kind of lodging repulsive to the troops. For all these reasons, it is necessary that, at all times, the casemates should be told off to their proper use.

On the other hand, if the casemates are occupied in peace time they will not fail to be provided with all necessary arrangements and accessories and indispensable ameliorations to be made, and by this means the number of works to be executed on the mobilization will be diminished.

If the vaulted casemates offer to the troops of the garrison who are resting complete security against explosive projectiles and fire, so much cannot unfortunately be said of blinded shelter constructed with wooden beams. These are a source of fire to the buildings they cover, and in case of fire, even in peace time, all that these buildings contain is lost, without the power of saving anything; even the lives of those who live in them are much exposed.

As it is evident that the soldier never will have entire confidence in shelters constructed with wooden beams, it is necessary to insist that permanent construction in fortresses shall be executed with incombustible materials (rails, T-iron, &c.).

A fortified place without casemates is not, properly speaking, a fortress, and military history cites numerous cases of fortified places which have not been able to offer any resistance, because the garrison had no shelter to protect them.

If there were time while the place was being put into a state of defence, or if the attack of the enemy advanced only gently step by step, attempts might be made to make the cellars of the place bomb-proof, by the help of wood and earth, and to have shelters made under the ramparts by miners.

Provisional casemates or blockhouses might even be organized if there were sufficient wood; but all these are only palliations, and it is unreasonable to allow the security of fortresses, whose construction and maintenance swallow so many millions, to rest on a happy chance, which in some particular cases has allowed of these means being employed at the last extremity.

To sum up, the defensive casemates, the store casemates do not suffice for the repose and security of the soldier who sheds his blood and his life in fighting and in the works of defence. What are necessary in this case, are good dwelling casemates placed under the terreplein of the enceinte.

The Barracks.—In fortified places the barracks that are usually built are worthless as regards defence. Indeed these barracks, having often two or three stories, offer no security against the enemy's projectiles. They offer too apparent an object, and are not the least sheltered from fire. Then, again, even when the exterior walls are of good masonry, the flooring, the stairs, the doors, the shutters, the door frames, the roof, are composed, in great measure, of dry wood, and consequently easily set on fire, whether by the enemy's projectiles, by imprudence, or by ill-will. The history of sieges offers, unfortunately, but too many cases of this kind of incendiarism.

If, in the enceinte of a great fortress, which is almost sheltered from bombardment up to the fall of its detached works, barracks and casemates have to be built, the barracks should be constructed of incombustible materials, and so disposed that they do not come above the crest of the fortifications. Each building should be inconsiderable, so as to disseminate barracks over the place, so as to sustain the effects of bombardment, and to have always at hand, in case of need, a reserve for men off duty.

These incombustible barracks can scarcely be exposed to the action

of shells; from this point of view, indeed, casemates are always preferable, and cannot be omitted in small fortresses, as the barracks are too much exposed to bombardment and to the concentrated fire of the besieger.

Billeting on the Inhabitants.—To do this is the worst possible way of placing the troops under shelter. In fact, private houses present all the inconveniences of barracks; but besides, the soldier is always an intruder on the proprietor with whom he lodges, and in consequence is always badly lodged. In addition, he continually hears wishes expressed for the giving up of the place, and his Chief's orders continually blamed. He is continually exposed to all the seduction of revolutionary politics; lastly, the control over him is very difficult.

If it is necessary during the bad season to canton the troops in consequence of insufficiency of barracks and casemates, a block of houses should be taken up to be organized as barracks.

Lastly, when in a fortress there are neither casemates nor barracks, it is still preferable to encamp the troops.

Cantonment of Troops.—In our climates troops can be encamped only during a few months of the year. For each encampment within the place it is requisite that the site should be quite sheltered from the direct fire of the besieger, and in this case it is still exposed to the high-angle fire of shells, for there is always the fear that the enemy will find out, either from deserters, or the clumsy replies of prisoners, or from spies, the position of the camp. As the white colour of the canvas may betray its position, it is well to tar the canvas in order to change its colour, otherwise the encampments may be formed of wooden huts, which are preferable to tents.

In whatever way it is done, it is always objectionable to encamp the troops, and this means should be had recourse to only where absolutely necessary.

All that has been said about the protection of healthy men applies naturally to the sick and wounded, we will therefore consider the subject of hospitals.

IV. Hospitals.

How is it that the soldier has, even at the present time, so much repugnance to enter into even a well-organized hospital? To answer this question, the author replies that from statistics it is proved that for 5 to 8 per cent. killed in action, four or five times that amount die in hospital, on account of bad organization, want of shelter, medicines, doctors, and because a collection of sick and wounded almost always breeds fevers, epidemics, &c.

The medical history of the siege and epidemic of Torgau, 1813, from Dorow, is so full of interest, as well as instruction, that it should be reproduced in the original text.

"The hospitals had become at Torgau veritable caverns of death. It had been found necessary to place the unfortunate soldiers so close to one another that they almost touched. Straw for lying on was wanting, as well as utensils, instruments, medicine, and healthy food. But, in addition to all, order and forethought were wanting. The

“greater number of the *employés*, of whom there were many, performed their work badly. Thinking too much of their own miseries, they did not attend on the sick soldiers with all the zeal requisite under the circumstances. It was in vain that the Governor, the noble Count de Narbonne, sought to raise the *morale* of these unfortunate people. His frequent personal visits, which proved deadly to him, produced no effect. The principal character of the disease was a diarrhœa of a corpse-like odour. In consequence of little care and surveillance, the dirt became so considerable that patients struggled in their own excrement and rotted like living corpses. In the hospitals of Torgau it often happened that a patient, consumed by a burning thirst, drank the urine of his neighbour with avidity, being unable to obtain any other drink. The dead often remained the whole day in the same bed, close to their living comrades. The strongest patients snatched from the weakest and the dying their straw for lying on, their blankets and linen, in order to procure some slight comfort for themselves. The greedy and diabolical hands of the hospital orderlies, instead of helping them, ransacked unceasingly the beds of the patients, and long before death had closed their eyes for ever the unfortunate dying man was already despoiled of all he possessed. The ambulances of Torgau were, properly speaking, nothing but immense cesspools. The greater part of the latrines, for which no care had been taken, and into which even the corpses were flung, were full to the mouth. They even overflowed, and putrid urine flowed on the walls and staircases. In the Chateau of Hortenfels each window served as a latrine; human excrements were stuck all over the walls. They formed immense heaps in the courts. In the wards it was almost impossible to open the doors, obstructed by ordure. It was necessary to pass over excrement, and to cross on the corpses, to reach those still living. All the glass had been broken by the bombardment, and as wood failed, it was necessary to take the doors and windows to heat the wards. These poor unfortunate creatures, very badly provided with blankets, found themselves exposed to the most severe cold, as if in the streets; many had their hands and feet frozen. Their drinks even froze beside them.

“There was not any treatment regularly carried out, even food was not distributed in sufficient quantity. Wood was generally wanting to heat the food, so that the patients received their nourishment quite cold.”

In the notes of the Deacon Burger what most interests us are the lists of deaths. The total number of French dead at Torgau reached the enormous total of 28,000 to 29,000 men, who perished without honour or glory behind the ramparts and walls.

Almost at the same period 21,000 French succumbed in the same condition at the siege of Mayence.

The author has given many instances, but the list of these horrors is too dreadful and harrowing for us to dwell longer on them; for what precedes is sufficient to bring out the extreme importance of a good hospital organization.

The rules laid down by the author for the good care of sick and wounded are as follow :—

Before all, it is indispensable to separate the patients according to their diseases. For this it is necessary, whenever possible, to establish two principal and two secondary hospitals. One of the great hospitals will be told off to receive patients with contagious diseases, the other will be for soldiers dangerously wounded. In one of the secondary hospitals the lightly wounded and men slightly ill will be placed. In the other those with itch and venereal.

In addition, a fifth locality must be chosen in the town to act as a reserve hospital in the event of its being found necessary to cleanse thoroughly and disinfect the buildings of the other hospitals.

Lastly, it will be well to have a special hospital for civil prisoners and prisoners of war. Also, it is well known from a hygienic point of view that several small hospitals are better than one big one.

Besides hospitals, ambulances for dressing wounds will be formed, an ambulance for each side of the front of attack, and one in the middle of each of the fronts not regularly attacked. Each detached work should have a flying ambulance established in the reduit. Lastly, in each sector of the defence, there will be a doctor told off to visit the troops off duty and the sick in their own rooms.

The conditions to be fulfilled as much as possible by the hospitals are :—1. To be completely sheltered from direct and vertical fire; 2. To be incombustible; 3. To have only a sunk story and a ground floor; 4. To have their accessories in isolated buildings; 5. The doors and windows of all the buildings should be provided with an iron grating to protect them against projectiles.

We will not here enter on the interior arrangement of the hospitals, into which the author enters in great detail, but which those charged with organizing this service may study with advantage.

Let us now see the *personnel* necessary in a hospital. One or two women will have charge of keeping it clean, one or two men told off to domestic work requiring strength. The care of the patients should be left to women, sisters of charity or willing civil nurses. A sufficient number of hospital orderlies to assist them will be added to their number.

To assist the surgeon in their operations, assistant-surgeons, already in practice, will be told off to them. In each principal hospital, an apothecary, to whom will be added an assistant apothecary, if necessary, will have charge of the dispensing work.

Care is taken of the patients by a certain number of doctors, who visit the wards, and who are all under the immediate orders of the principal doctor who directs the hospital.

The military police of the hospital is performed by the company of stretcher bearers.

One cannot lay too much stress on the looking after and stimulating all those who, in a siege, are employed in the hospital, to force and encourage them to fulfil conscientiously their heavy and dangerous duty.

To each ambulance of a fortress should be told off a doctor and

an assistant. They will be assisted in their service by a piquet of the company of stretcher bearers, who will be quartered near at hand.

All the doctors of the hospital, ambulance, and sector are each, in what concerns him, under the orders of the principal doctor of the fortress.

Whatever belongs to the hospital should be submitted to a strict and severe control. The control will be first by the Governor and second in command, then by the board of health, of which we will speak later. It should also be insisted on that the interment of a deceased man in a hospital should only take place when the identity and death of the person has been officially verified.

If we take the accounts of writers, the number of patients cared for in the hospitals may, in a siege, amount to a third of the garrison. It will be seen, then, that a good hospital organization requires in each fortress considerable *personnel* and *matériel*, prepared in peace time, like most things in war.

V. *The Supply of Provisions.*

Frederick the Great said once, "The stomach is the base of the army." This truth, although expressed in a crude form, has not up to the present been contradicted.

One of the great military virtues is to know how to support privations, but on the condition that the privations are the result of the force of events, and not of a bad administration or of an ill-placed parsimony. At all events, it is a gift on which one cannot count, and it is necessary to take all possible precautions in order that the soldier may be always fed; much more can be then demanded of him.

The supply comprises—Food for men, forage for horses and slaughter animals, fuel, medical comforts, lastly, various objects, such as disinfectants, tobacco for the men, &c.

The old tables of supply, compiled by Vauban and his successors, cannot be depended on at present. The German General sets himself against the tendency to calculate the necessary supplies, by deducting for the losses a quarter of the effective of the garrison, and basing on the number of days during which the place and the works should theoretically resist a regular attack. We will not follow him in his arguments and in his developments, for they are based on the experiences of the past which we believe have been taken account of for the future.

Nevertheless, we believe we can reproduce entirely the argument and the following conclusions.

At the present time, when, in the whole of Europe, all classes of society have abandoned the simple and frugal kind of life of their ancestors; when the desire of living well, dressing well, amusing one's self, has penetrated, in an astonishing manner, into the mass of the people; when the prestige of authority is more or less enfeebled, it is necessary to expect that people will rather capitulate than support hunger, and even passing privation. Hunger causes death, privations enfeeble the body, and each one wishes to live long, in order to enjoy life as much as possible.

From this the conclusion is arrived at that at the present time the greatest care must be taken to provision a fortress with regard to quality and quantity. As to quantity, the food must be calculated according to the complete effective of troops and auxiliaries, for a duration exceeding, by a month, the probable time of the resistance of the place. For, during the defence, part of the provisions may be deteriorated or burnt.

Assuredly, in former times, they thought differently. Then, as they distributed sparingly to the soldiers the coarsest and worst food, there was not the same reason to wish that the defence should be abandoned as soon as want of provisions made itself felt.

We ought, however, to remark that if, as in certain bygone sieges, one must not dream of feeding troops with flaxen bread, asses, cats, or dogs' flesh, or of boiling skins, leather, and even corpses for food, one must allow that the siege of certain French places, during the late war, of Paris in particular, has proved that softness of manners has not done away with all patriotism, and that the populace, as well as the army, knew how to undergo, admirably, all privations, and how to support themselves with all kinds of food.

Besides, the author himself admits that, if the soldier should know how to support all privations, to surmount all fatigues, to sacrifice his life generously on the field of battle, he should always strive not to sully his honour by traits of barbarism, and should try not to gain the aureole of glory and victory at the price of acts worthy of cannibals.

It would be idle to follow the author in the numerous instances adduced of strong places that have surrendered through want of provisions. We will say that it is the most frequent cause of capitulation. The last war has given us many examples of this.

These examples make this fact stand out, that, in the greater part, the same faults were committed. There had been no idea at the commencement of hostilities that the strong place could be attacked so promptly. Also, as soon as there was, all of a sudden, the certainty of the defeat of the army, which was quite unforeseen, they were taken by surprise, and could not be provisioned properly.

General Kamptz's principles for the provisionment of fortresses, based on these facts, are as follows:—

1. Experience having proved that the loss of a single great battle drags with it generally the fall of several strong places, it is necessary, at the outset of hostilities, not only that the fortresses should be in a perfect state of defence, and should possess the garrison and munitions of war necessary, but they should be provided with food in sufficient quantity.

The fortresses near the theatre of war, and which can at any moment expect an attack of the enemy, should be provisioned completely from the declaration of war. It is necessary, as soon as possible, to take the same measures for strong places, at considerable distances from the theatre of war.

2. War, both that in the field and that of sieges, will demand in the future great means from each side. War in the field will progress generally more swiftly, and will advance rapidly to decisive and im-

portant battles. But, however, the war may be prolonged, if the first places attacked, which command the fortifications, resist, and so give time to the invaded people to collect all its elements of resistance.

In this case the siege war will exact, as formerly, much time, perhaps even more time than formerly. For the great range and effect of the new and perfected firearms will render it necessary that the course of attacks should be more prudent and, consequently, more slow.

From that we can deduce this second principle. The fortresses which are in the theatre of war, and the maritime places in the region of action of the enemy's fleet, should be provisioned at least for a whole year.

It may, perhaps, be said that a defence which lasts a whole year is an exception. This is possible, but it is much better to have too much food than too little. Besides, there are necessarily losses arising from waste, from fire, or from deterioration of food; in other cases, the garrison of the place may receive, even without desiring it, great reinforcements, and troops which keep in the open, deprived of food, may come to take refuge under the guns of the fortress, and there establish an entrenched camp.

From this last point of view, what passed at Metz in 1870 may be remembered. From another point of view it is impossible to insist too strongly on all the inhabitants of a strong place being provisioned for at least six months from the declaration of war, and on taking the most rigorous measures to hinder the inhabitants of surrounding villages coming to take refuge in these places, if they do not satisfy this condition. Besides, whatever may be done, in a siege of a certain duration, circumstances may arrive which oblige aid to be given to the civil population. Prisoners of war also cannot be allowed to die of hunger.

For places which are far from the theatre of war, it may be sufficient before the declaration of war to provision them for six months.

In the calculation for provisioning, the rations for the entire garrison must be taken as a basis, and the garrison must be considered at its full strength throughout the siege, including all auxiliary employes. In what concerns the quality, choice of provisions, and price of the rations, one should consider the season, and the manner of life of the surrounding population.

In all cases care must be taken to vary the food, and when exceptional efforts or fatigue is demanded from the troops, coffee or some other liquid must be served out. Above all, the greatest care must be taken with regard to the nourishment of the sick conformably to the doctor's prescription.

Water being a drink of the first importance, all necessary disposition must be made in order to procure the water necessary to support life, under all circumstances, in a besieged place.

We will not enter into the details given by the author as to watching over the supply of drinking water, of controlling the breweries, distilleries, butcheries, and bakeries, or for supplying or completing the resources that this kind of establishment can supply.

It is unnecessary to say that in all small fortresses or detached forts, all the supply cisterns, butcheries, and other necessary accessories must be protected from shell fire.

It is important to decide in advance, during peace time, upon all measures to be taken to assure the provisioning and to make them known to all concerned; but above all it is indispensable to give the Governor the right of controlling the dispositions, taken by the civil authorities, for provisioning, and to stir them up if necessary by energetic measures.

As the Governor, during the arming of a fortress, cannot be occupied personally with details, he will delegate his powers to a committee, to which he will attach an employé experienced in the service of supply. This committee, presided over by an energetic Officer of the staff of the garrison, has not only to see to the reception of the provisions which arrive at the fortress, it should go to the various places where deliveries of food are made, to be sure of the quality and weight of the provisions, to cause what is bad to be exchanged, and to hasten their removal to the fortress. In the event of urgency or of delay, it can make requisition by order of the commandant.

When the provisioning of the place has been seen to, this committee controls as regards quantity the provisioning made by the inhabitants, and sees to the storage places for combustibles. From the results of its researches a list of the inhabitants will be made out who should be expelled from the fact of their having no food. In this list those only will be allowed to remain who promise to serve as workmen or mechanics, or as aids in the duties of the fortress, and who are recognized as used to the work.

The provisions should be placed under shelter from the enemy's fire, from conflagration, from deterioration, from theft, from waste. As far as possible, the stores should consist only of a sunk story and a ground floor of little height.

All the stores should be incombustible, and should be separated, so that fire cannot communicate from one to another. In default of very dry casemates in sufficient numbers, and of magazines proof against shells and fire, the use of pits may be advisable for the preservation of certain provisions, such as grain, potatoes, peas, rice, &c.

The storing and manipulation of the provisions must be left to employes of the supply service, who understand them; but the committee spoken of above should control and verify everything. Great attention should be paid to the choice of dépôts for combustibles, and in their storage.

As regards the herds of cattle, it is necessary above all to take the necessary measures to keep them in good order, that is to feed them well, to keep them very clean, to shelter them from wind, rain, and cold. The use of sheds and cattle yards adjoining, is recommended. To watch the herds, well-known townspeople are employed, and a watchman is placed in each cattle yard.

Finally, in order to have fresh vegetables in the place, at any rate for the hospitals, all the public gardens which are not part of the works will be turned into a kitchen garden.

VI. The Employés of the Administrative Services in a Besieged Fortress.

The employés of a fortress include those employed in the hospitals, supply and barrack departments.

Here the author explains at length the causes that hinder military employés from obtaining the soldiers' confidence. He bases on the facts which occurred at Dresden in 1813, and at Mayence in 1793 and 1814. That guilty acts and malversations have been committed is a thing that may always take place in every country, but one must admit that it is the exception, for the last wars have not disclosed facts so deplorable. Such acts can only occur from want of organization and surveillance.

It is of the utmost necessity to place under the authority of the deputy commandant and the president of the board of health mentioned above, all the employés of the administrative services, from the declaration of siege, which gives special military powers to the Governor. The president of the board will be specially charged with the inspection and control of these employés.

This close inspection should be desired by honest military employés, as it allows true merit to be appreciated. It is necessary that the military employés should share the honour and fate of the garrison of the fortress; if it falls they will be prisoners of war; if it resists they will have a right to the same advantages and honours as the troops.

The distribution of food, utensils, &c., should always be made to the troops under the surveillance of an Officer, and the rules in peace time should be carried out strictly. It is necessary besides that Officers should make it a point of honour, to have at all times the greatest solicitude for those directly under their command, that they should see to their men before going to rest, that they should visit them in the hospitals, in prisons, &c. For the care that an Officer takes in the welfare of the soldier and in sparing him privation, awakes and strengthens his confidence in his chief, and forms an indissoluble tie between them in time of danger. We will add it is at the same time a powerful means of preventing abuses.

VII. On the Dress of the Soldier and Military Workmen.

It is indispensable to give a uniform to the companies of auxiliary workmen formed for the service of the artillery and engineers, for by this means obedience is more easily obtained. Otherwise it would be necessary to guard these workmen by patrols.

VIII. The Board of Health.

The board of health, of which we have spoken above, have to inspect the supply of provisions, their arrival in the place and their preservation. They have, above all, to control the hospitals in all that concerns order, cleanliness, and food: they make themselves acquainted with the way in which the men are fed and lodged, and they have under their control all employés of the fortress. They see besides to keeping the streets, &c., clean, to the health of the town, and to burying the dead.

The president of this board should be an energetic superior Officer,

possessing the entire confidence of the Governor. He is also permanent member of the defence committee and his advice in everything concerning administration questions should have great weight. Although he may be under the orders of the deputy commandant, he should, however, remain alone responsible directly to the Governor for orders given on the spot in urgent cases and on his own authority. He alone is charged with having the decisions of the board carried out.

As permanent members, one of the senior Officers and the principal medical Officer of the garrison form part of this board. The three form the office: to them is attached the director of supply, the director of administrative services, the town Major, doctors, an employé of the judge advocate's office, and in certain cases delegates from the town and experts.

The office has at its disposition a non-commissioned officer and two soldiers of the auxiliary company as clerks.

IX. *Burials.*

It is evident that in a besieged place all measures and precautions allowed by circumstances concerning the interment of the dead must be taken. We have not here to insist on the hygienic or other dispositions to be taken in this case; but it is absolutely necessary to organize a service for burying the dead and to control this service rigidly.

A committee, presided over by the town Major, and of which a clergyman, a doctor, and a delegate of the town form part, is charged with this control. Two members at least should assist at each burial. During the continuance of the siege, burials civil as well as military should be made without any apparatus, without any service, without any cortége, and with as much simplicity as possible. The lists of dead will be filled in by clergy of the particular persuasion, and sent to the town Major, in order to note them and later on to make out the official death report.

X. *Organization of the Guard-Service in the Interior of a Fortress.*

Besides the service of active troops for the guarding and the defending the works, it is indispensable, in the interior of the place, to watch and guard all military establishments, and certain establishments or civil administrations, on which depends the security of the place. This service includes the guard of the following establishments:—

1st. Guard for powder magazines. This guard is furnished by the troops of the sector of which the powder magazine forms part. With the dispositions actually adopted for these magazines, a single sentry is sufficient for each.

2nd. Guard of the laboratories. In a laboratory there ought to be at the utmost 100 kilogrammes of loose powder. The ammunition as soon as filled is taken to the expense magazines. To watch the workmen a purely military sentry has more authority. After work this sentry can be relieved by an armed section of the auxiliary com-

pany of workmen: this slightly diminishes the duty of the active troops.

3rd. Guard of the gun parks, of the parks for projectiles, dépôts for tools, *matériel*, &c., for the artillery service.

4th. Guard of the engineers park, of dépôts of *matériel*, of tools, of supply, &c., for the engineer service. To ease the active troops, men belonging to the companies of auxiliary workmen may be mounted on guard with captured arms, who are attached with this aim to the troops of the guard of the sector, and who on standing to arms take the left of the guard.

5th. Guard of the public chest. The number of sentries necessary for this service may be lessened by concentrating all the public chests in one locality. Besides the cash operations can be more easily controlled by this means.

6th. Guard of the food and forage stores. This guard is given to the troops of the guard of the corresponding sector.

7th. Guard of the towers and clocks. An observer placed in a tower has not only great facility for seeing the whole horizon, but also he can see into the folds of the ground. During a siege, therefore, Officers who thoroughly know the environs should be placed in observation in the towers, to whom may be attached, if needed, inhabitants who are beyond suspicion. These observers, provided with good spy-glasses, dictate the result of their observations, to a discreet and faithful non-commissioned officer, after having first transmitted them shortly by telegraph to the Governor. The written despatches are carried by a permanent orderly in a leather bag closed by a lock.

When the regular attack is commenced, photographs may be made by a trustworthy photographer from the top of the tower, of the attacks which serve as special reconnaissances, which the Officers of artillery and engineers carry out each day. It is even possible, by the aid of a photographic apparatus, to fix what can be seen in an instant, by the light of a bursting shell or a reflector; all that is lit up gives a photographic image. The employment of photography on towers can render good service to the defence.

As observations from towers may go on by night as well as day, either by the light of the moon or by means of light-composition (pieces of ordnance, rockets, or mirrors), as it is possible in a dark night to perceive each light shown by the enemy, as lastly, in a calm night it is possible to hear different noises, it is necessary to relieve the watchmen at least twice in twenty-four hours. In consequence, the *personnel* required for observations is for each post, 2 Officers, 2 civil assistants, 2 non-commissioned officers as clerks, 2 telegraphists, 2 orderlies, and 2 photographers. There will always be on duty in the observatory one of each of these lists, which makes a total of six people present.

Precautions should be taken not to allow any unauthorised person to enter, especially when the towers contain bells, for the latter, generally speaking, should only be sounded by order of the Governor. It is necessary also to post a sentry at the door, who will be furnished by the nearest guard. It is unnecessary to say that observers ought

to be careful to conceal, as long as possible, their presence from the enemy, and, consequently, to show themselves as little as possible.

8th. Guard over gasworks. If these works are exceptionally far beyond the enceinte, it is necessary in peace time to surround them by works and to place in them a special garrison as soon as war is declared. But even when these buildings are surrounded by works, the town and the fortress remain exposed to the greatest inconvenience if the works are attacked and the gasworks fired on.

As an absolute principle, it is necessary, then, to insist that gasworks shall be placed within the enceinte of a fortified place, that the buildings shall be protected from direct fire, that the walls should be proof against it. Besides the position of the works should be chosen so that an explosion of gas cannot set fire to a powder magazine, or to any provision stores. Lastly, it is necessary to prevent buildings for the production of gas, being sunk into the ground.

During a siege, gasworks require to be controlled and need military guard. The control should be exercised by the employés of the excise stationed on the works. The guard is furnished by the garrison and the management of control and guard belongs to the town Major.

If, for lighting streets, squares, &c., it is wished to replace gas by oil lanterns, all the apparatus for lighting must be obtained during peace time and maintained ready. It is a very costly and inefficient method.

9th. Guard of railway stations. As with gasworks, it is a great fault to construct stations outside the enceinte of a fortress, inasmuch as it is necessary to surround them with fortifications. But these works always have the disadvantage of increasing without necessity the number of detached works, of requiring a more numerous garrison, and of increasing the limits of the fortifications. Besides, the stations enclose a considerable amount of *matériel*, rails, locomotives, tools, which should be taken away from the enemy, brought into the place and utilized for the defence. When the stations are situated in the enceinte of a fortress, the transport of the *matériel* is saved and the waiting rooms and carriage sheds may be used for the picquet, for placing there slightly wounded men, or convalescents, &c.

10th. Guard over prisoners of war and men detained. Soldiers punished with imprisonment and convicts will be employed in transporting engineer *matériel*, and should be, as far as possible, superintended by old retired non-commissioned officers. After working hours they will be locked up and guarded by sentries.

Those condemned under the second category are conducted to the work under the surveillance of armed men, and treated generally as in peace time; the engineer service will employ them in preference for repairs to roads and earthwork.

The magistrate of the town should have the civil prison guarded by a civic guard. The civil prisoners will be employed preferably in cleaning the streets and squares, those condemned to hard and ignominious labour will empty the latrines and sewers.

The prisoners of war. The defenders of a besieged town generally make little use of prisoners of war, but a large number of prisoners of war may have been interned in fortresses by the active army.

It would be a great mistake to shut up prisoners of war in a fortress situated at a short distance from the threatened frontier.

The prisoners of war made by the besieged ought never to be collected in hundreds, but should be scattered about in small groups and imprisoned in various works of the fortress. They must be prevented having any means or occasion of communicating with the exterior. The author lays down the principle that prisoners of war should gain their living by work, should be charged with the heaviest and most repugnant work, and that bad food should be given to those who will not work. The Officers who are prisoners should be watched and treated with the greatest rigour. They should not be free to circulate and to meet as they wish; their ornaments and money must be taken from them, and given back by degrees, so as not to allow them to corrupt any one. These Officers should be shut up, should only take air or exercise for their health at fixed hours, and watched by armed men. The town Major has the responsibility of their being present; sentries guard the doors of their prisons the same as those of the soldiers; frequent patrols are also made.

It is a question whether this excessively severe method of treating prisoners of war is wise, being apt to bring about reprisals.

Any outbreak should be repressed with the utmost rigour. The guard over the prisoners of war is told off from the troops of the garrison, who also furnish patrols for the service. It is a heavy burden for them, but unfortunately it cannot be otherwise.

XI. *On the Organization of various Services indispensable in a Fortress.*

1. *The Telegraph.*—The telegraph is a means eminently suited to place the Governor who directs the defence of the whole fortress at once in communication with those who are under his orders, and who command in the detached works and in the sectors of the place. It is indispensable that subterranean wires should diverge from the quarters inhabited by the Governor in war time, and should end in shelters near the commandants of the various forts. The organization of this service should be made in peace time, to diminish the number of works to be executed at the time of placing the fortress in a state of defence.

It will be well to have the same telegraphic apparatus as those used in peace time. By this means the first can be kept up to the latest improvements, and, if necessary, the latter used. Lastly, the employés of the State telegraphs can be utilized, so that it is unnecessary to tell off non-commissioned officers of the troops for the service.

The telegraph service being naturally carried on by day and night, it follows that two employés are necessary for each fort. While the garrison holds the country in front the telegraph of the country must be used. There will then be time to organize this service. All the telegraphs will naturally be under a special Officer. Besides the military telegraphs, in large towns, a special telegraph system must be organized for the town, so as to be able to transmit orders, &c., to the police to the different quarters, and to warn at once the fire brigade posts of the districts where fires break out, in order to

extinguish them at once. The *personnel* will be recruited as for the military telegraphs among the telegraph and post officials.

The author does not speak of visual signals, probably because, at the period when he wrote his book, this was not perfected enough to give practical results. An article in the *Bulletin* of 16th September, 1876, and, above all, the study of various optical instruments intended to throw the electric light on distant objects, by M. Mangin, Lieutenant-Colonel of Engineers, inserted in No. 25 of "Memorial de l'Officier du Génie," prove that this is now a resource on which to count in the defence of places. This service must then be organized in time of peace.

2. *Despatches in Cypher*.—The cypher employed by the Governor to send news outside should be the same as that which the Chief of the State and the Generals employ to give orders or news. The secret cypher, and the key for decyphering it, ought to be confided to him before the commencement of a campaign.

An Officer should be placed at the head of the department for cypher intelligence; and, as far as possible, it will be the Officer in charge of the Intelligence Department.

3. *Signals*.—Signals are divided into two categories, visual and by sound.

The visual signals have the inconvenience that they warn the enemy, and during the day-time they do not render all the service expected of them. As visual signals, rockets or different coloured fires may be used to keep up communication with a relieving army or with people outside. Otherwise the system of visual telegraphs of which we have spoken above is preferable, and will probably supersede the use of these signals.

Signals by sound, which can be made by the instruments in possession of the troops, or by means of bells, are generally employed in the interior for reinforcing the troops on duty.

The Governor should have signals which, in moments of danger, indicate the amount of reinforcement necessary. It is impossible to insist too strongly on the advisability of only calling up reinforcements successively and at the right moment, not only in order not to fatigue the troops, but still more to conform to that principle of military art, which considers the economy of force the most sure means of prolonging the resistance.

By the combination of bell, trumpet, drum, &c., all the necessary signals can be made, but it will be wise only to make very simple signals, that the troops can be made to understand. They will suffice for all circumstances by combining them with the telegraph.

4. *The Police*.—In a fortress declared in a state of siege, the police arrangements belong naturally to the commandant. But it is necessary in this case to enrol in the service of the State the employés of the civil police, and to take the necessary precautions to assure their complete independence. In the same way as the police, the night watchmen, lamplighters, street scavengers, watermen, and chimney sweeps, should form part of the service of the place.

The police of the fortress has to prevent anything going wrong in

the interior of the town, or any accidental or premeditated assembly being held which would hinder the resistance.

A list is made by them of all persons to be sent out of the town ; in this list may be put all persons deprived of their civil rights or placed under the surveillance of the police, all suspected strangers, those inhabitants unable to collect sufficient provisions or fuel, or those who are unable to gain a living during the siege, agitators, &c.

The only assemblies permitted are those for Divine Service, or which are authorized by the commandant. At night, each inhabitant who goes out must have a lantern lighted. The cafés and wine shops will be closed. At the alarm, the inhabitants must light up the windows of their ground floors and enter their houses. The police is charged with the execution of these orders, as well as those for prevention of fire, and with regard to sanitary precautions for the public health.

A special office should be established for censuring the press and watching the printing establishments. The publication of a journal of the fortress would be an excellent plan for publishing certain facts, for directing certain indispensable measures, and certain precautions to be taken in the general interest.

In fact, the director of police should have the confidence of the two commandants, and be an energetic man with a good head, and if not, he should be replaced by an Officer possessing qualities necessary for the post, or able to acquire them quickly.

The control of the police of the fortress should be specially under the deputy commandant, who has the town Major to help him in this branch of the service.

The gendarmes of the place, with those of the environs, who have to retire before the enemy, form the military police during the state of siege.

5. *The Secret Police.*—Military history proves that is a necessity to have in a besieged place a secret police. They must be formed, and must begin to work as soon as the place is declared in a state of siege.

The secret police will make investigations in the interior of the town and fortifications. They will, above all, watch persons suspected of being wanting in patriotism, assemblies, societies, and those who organize them, public houses, strangers, travelling merchants, and public buildings. The suspected persons will be watched closely without their knowing it. Their correspondence will not be intercepted, as use may be made of their answers. They will cause the habitations of suspected persons on the rampart to be vacated, also the upper stories of certain houses from which signals could be made to the enemy.

If mutinies among the troops are to be feared, if desertions increase too much, the secret police will seek to discover the plots in the midst of the garrison itself. It is necessary also that the Governor should also be informed by the secret police of any intemperate remarks made on the subject of the feebleness of the fortress, want of food, of ammunition, &c., by Officers or military employés in public.

To conclude, each agent of the secret police should have a distinctive mark, to enable him to be recognized in extraordinary cases.

6. *The Intelligence Department.*—It is in the nature of things that a

garrison can only endure with the greatest impatience being shut up in a fortress, and completely isolated from the exterior world; therefore attempts ought to be made to keep up or re-establish communication with the exterior.

Until the enemy has the numerical superiority, and has invested the place completely, the Governor will not fail to have, by means of reconnaissances, patrols, and well affected persons, very exact intelligence as to the enemy and his movements. It only remains, then, to speak of the information that the Governor can procure after the complete investment of the place.

All news obtainable is of the very highest importance, for in most cases it determines the procedure of the defenders. To procure news spies and emissaries will be employed, the secret police will open the letters, and will interrogate the prisoners and deserters.

Spies will be found everywhere, for everywhere the allurements of gain will always procure men capable of doing anything. But to be well served in this respect, it is necessary to be extremely liberal towards spies, while, however, taking the precaution of keeping hold on their families and possessions.

Emissaries are individuals who give the same services, not for money, but for patriotism or through hatred of the enemy; very often they offer themselves without being asked. Military history tells us that even Officers have acted as emissaries, either by bringing news into the fortress or carrying it out.

Experience then shows the necessity of having recourse to secret police and to spies. This must be admitted in principle, viz., that a small evil must be tolerated in order to ensure a great good.

The intelligence department is naturally charged with collecting the observations that have been made from towers or elevated places. These indications are completed or rectified by special reconnaissances, which the Officers of artillery or engineers make, and by the news given by the commanders of sectors.

The chief of this department should be an Officer of the staff of the Governor who knows thoroughly the fortress, the environs, and siege warfare, who possesses the gift of combination, who knows how to keep silence, and has the whole confidence of the Governor.

One means, not touched on by the author, of having news from the exterior in an invested place is visual telegraphy, which, even with the present organization, cannot fail to render great service, as, for example, the flashing signals used to communicate between two points 30 miles apart during the Zulu War, 1879.

It must be recognized that in all that concerns secret police and spies the Germans are masters, as, unfortunately for the French, was proved in the war of 1870-71. One may consider the measures proposed by the author as on this subject complete.

7. *The Surveillance of the Inhabitants.*—According to the author, the enemy can easily make active allies in the fortress, above all by sowing discord between the inhabitants and garrison. There ought not, therefore, to be two armed forces quartered alongside each other in a fortress, for soon there will be disturbances between them. Also, as soon

as the fortress is placed in a state of siege, General Von Kamptz demands that the inhabitants deposit all their arms and ammunition, colours, trumpets, &c., that they possess at the arsenals, and that the same precaution should be taken as regards gunsmiths and merchants in iron who have materials for making arms.

A loyal feeling on the part of the defenders is one of the elements that contribute most to the duration of the defence. If it is possible to strengthen it, to keep it up for a long time, an excellent result will be obtained by establishing a moral solidarity between the garrison and inhabitants. It is a powerful stimulus to raise and strengthen the courage and confidence of the troops.

A garrison can never free itself from the support of the inhabitants, for it cannot suffice for everything, and if it is obliged to force the inhabitants to work, troops will be required, which will correspondingly diminish the effective strength available for the fight. From this it will be seen a good feeling between the garrison and inhabitants should be sought to be established.

From the commencement the Governor should act so that while not showing at first entire confidence in the population, he has not the air of mistrusting a part of the inhabitants. It is necessary that all measures taken with regard to them can only be considered as a wise precaution, and it is important to hold the balance as much as possible between boundless confidence and absolute mistrust. One proof of confidence to accord to the inhabitants is to take from among them a part of the force required to work the big guns.

The Governor can also tell off some good civilian rifle shots in the different sectors. It is necessary to draw on all the elements in order to organize the various auxiliary service enumerated above; auxiliary workmen for artillery and engineers, sick bearers, superintendents of works, constables in the police, guards to prisoners, firemen, employés in the hospitals, &c. But an organized civilian troop should not be formed, as it is to be feared that this troop will only cause the inconveniences connected with all national guards and militia.

If the Governor assumes the part of mistrusting the inhabitants, he should employ, during the whole siege, energetic means for suppressing all revolts. To maintain peace and tranquillity in the interior of a fortress, sufficiently strong cavalry patrols will be employed to prevent any crowd collecting; if the infantry and cavalry are not sufficient he must not hesitate to employ artillery. In fact, he must refuse the inhabitants leave to go on the works of the place, and prevent them speaking to the troops on duty.

It is good then to have all in train to stifle any attempt at revolt, and to subdue it energetically in case it breaks out. The troops to protect military buildings and stores, from an attack in force, should be told off beforehand, as well as those to secure communications necessary for the defence.

From the commencement of the siege the populace should be informed, that the troops have the formal order to use their arms on the slightest resistance.

The signs of a coming revolt cannot escape the Governor, who

ought not to allow himself to be deceived by the civil authorities on this head. The Officers and military employés, who are obliged to have dealings with the populace and police, unless utterly incapable, cannot fail to discover if conspiracies are hatching.

We agree with the author that it is much better to prevent a mishap by swift and energetic repression; but to this end it is necessary not to forget the zeal (often intemperate) of the police and of others stimulated either by patriotism, or the allurements of a reward. It is therefore well to receive all exports carefully, and to act only in good earnest.

8. *The Council of Defence.*—The superior council is instituted to give support and counsel to the superior commandant, who will assemble them whenever he considers necessary.

But it is always the Governor alone who decides at last. This prerogative is indispensable for unity of view and authority of the Officers commanding. We will only admit one exception to this rule, when the Governor wishes to engage in *pourparlers* with the enemy for a capitulation. Thus, even when the want of provisions and means of defence would justify this extremity, the advice of those who compose the council ought to be demanded to conclude a capitulation. The council of defence in a fortress is what a council of war is in an army in the field.

Here is what the Archduke Charles thought of all councils of war, and which applies to the council of defence. "Few men," says he, "have sufficient strength of mind and profound conviction to have under every circumstance an opinion ready, and to express it freely without any thought. Nothing so wounds self-love as criticism of an erroneous idea. This criticism injures him whose plan fails, for the generality of people judge of the worth of a resolution only by its results."

Every man summoned to a council of defence or war comes there with the idea that the commander finds himself in a critical position, and that he wishes to hear some advice to avail himself of in case of non-success to cause his responsibility to be divided with others, and even to throw it entirely on them also. The greater part of those who are called to the council, come there with the fixed idea of compromising themselves as little as possible by expressing their opinion, as those who are against them are more numerous.

This explains how all councils of defence make themselves remarked by the timidity of their decisions. They wish to divest themselves of the danger of the moment, of the hazards inseparable from a manly action, without thinking that by so doing they run much greater danger.

The Governor will be able, in critical circumstances, to summon his council, to convince himself, from the advice of the members of the council, that his opinion is well founded, and to know that his resolution, already taken, has approvers, if it does not appear too rash or audacious to those who should concur in its execution.

According to military authors, there should be in each fortress two councils of defence, the small and the great.

The small council of defence is composed of—

1. The deputy commandant of the fortress.
2. The commanding Officer of artillery.
3. The commanding engineer.
4. The senior Officer of the garrison.

The great council of defence, which the Governor consults on all questions of administration, includes, besides the four persons mentioned above—

5. The president of the board of health.
6. The chiefs of corps of arms composing the garrison.
7. The commandants of sectors.

The Governor has always the right of hearing the heads of the special branches, at the council of defence, if circumstances make it necessary to call them together. For example, the principal medical Officer, the principal commissariat Officer, and the director of police, may assist at the council of defence, and express their opinion, but they never have any part in the deliberations.

The State of Siege.

The placing in a state of siege should be notified by the Governor publicly, and in accordance with the regulations. It applies not only to the garrison, but also to the inhabitants of the town and environs. The military Governor takes into his own hands all the civil and military powers of the place. His first duty is to see to the provisioning and arming of the fortress, and to place the garrison on a war footing, and see to the measures to be taken. Among these are the utilization of large buildings, such as convents, hotels, places of amusement, &c., which are of service for the defence, mills, breweries, distilleries, slaughter-houses, &c. The levelling of the suburbs and the inequalities of the ground in front, as well as the demolition of buildings in the town—for instance, all houses abutting on the ramparts must be razed. Cases have occurred where the defenders have had to evacuate the ramparts, owing to the heat of the burning houses close in rear, as, for instance, Stralsund, 1678, Wittenberg, 1760, &c. In a word, all the services mentioned before should be organized.

This finishes the first part of Von Kamptz's work. It may be seen by the analysis that the questions studied by the author have been considered fundamentally, and examined in all their aspects and in great detail; though they will probably be considerably altered by the advance made in the question of armament and fortification, nevertheless, this study contains many useful general maxims, more or less applicable to all cases.

SECOND PART.

As the author explains in the introduction, the second part has as its object, to complete the various points mentioned in the first part, that the experience of the sieges of 1870-71 has shown to be defective or insufficient.

I. *Means for Providing Money in Besieged Places.*

This chapter treats of the desirability of diminishing the necessity for money, during a siege, by executing before the investment all the works for placing the fortifications in a state of defence that can possibly be done.

When however, in spite of all the measures taken, money becomes scarce, the commandant must endeavour to obtain it, and must take the steps necessary to procure it.

One means which suggests itself is to force the line of investment, at any rate, by several sure and faithful messengers, when possible.

In a friendly country, loans can be obtained from bankers or rich inhabitants, or all the plate belonging to churches and private people, may be converted into money. Lastly, as an extreme measure, paper money may be issued.

It is evident that, in an enemy's country, the commandant will be constrained, in principle, to have recourse exclusively to severe measures, to procure the money necessary for payment of the garrison, and for the other heads of the defence. But then he is always relieved from all care of the inhabitants.

II. *Of the Care to be given, by Women, to the Sick in the Ambulances and Hospitals.*

After having recalled the fact that, from all time, women have made it a duty to lavish their care on the sick and wounded of the garrison of a besieged place, the author expresses his desire that the sick and wounded should be taken every care of. To attain this end, experience shows that females understand admirably this service, which is as difficult as delicate, and the sister of charity may be considered as the type of the sick nurse.

But in war time the numbers of sisters of charity are insufficient to complete them; devoted women, ready to fulfil their functions, are not wanting, but who are not always trained. For this reason, General Von Kamptz wishes to organize, in peace time, a service of this kind to train sick nurses, and to have, in war time, a sufficient number of trained persons.

It seems unnecessary to enter on the details of this service, as it is a want that has been recognized in our service, and in many towns classes have been started, under the auspices of the Order of St. John of Jerusalem.

Evidently the presence of sisters of charity and devoted women who lend their assistance suffices to do away with the abuses and the rough treatment of the hospital orderlies, while ameliorating the sufferings and raising the morals of the patients. Of course persons of good family should not be charged with the heavier and more unpleasant functions, and the respect they deserve should be exacted for them.

The author establishes besides a well-marked distinction between the sick nurses charged with the care of the sick, and the hospital officials in charge of more arduous works. He lays down minutely

their respective attributes, as well as the way to form and recruit this *personnel*; but the details would only interest medical men, and are therefore left out of this sketch.

III. *Disinfecting and Baths for Cleanliness.*

Diseases of an epidemic character often break out in besieged places, and therefore it becomes indispensable to organize a service for disinfecting, for purifying, for thoroughly cleansing, and if these means are not sufficient, for burning the body linen, the clothes and bed linen, as well as any camp materials. It is then necessary to prepare for each hospital a disinfecting establishment in a conveniently situated position (on a stream of water or an open spot).

The construction of this kind of establishment may be left to private enterprise; but it is necessary to insist on the contractor washing and cleansing effects belonging to the State, according to a tariff fixed on by the commandant, and on his submitting to the control of the military administration at all times.

We will not reproduce here the suggestions given by the author as to the means to employ in different cases, and for different kinds of effects, as that belongs to specialists. The author insists on the surveillance that the Officers should exercise as to the cleanliness of the men and their effects.

All that is connected with sanitary arrangements lies within the province of the board of health. As inspectors, persons well known in the town may be told off, for the inhabitants have at least as much interest as the military that all orders relating to disinfecting should be rigorously attended to.

In peace time, the care of causing the fortifications to be disinfected, for instance the ditches, naturally falls to the engineer Officers, but it is the duty of the commandant to suggest these cleansings, so as to keep the garrison and inhabitants free from epidemic fevers. General Von Kamptz recommends at length the culture of sun-flowers in the ditches and marshy places, as a preventive measure. Lastly, if burial places cause disease, from putrid exhalations, the author does not hesitate to demand the cremation of the dead.

Baths for Washing.—It is recognized that baths for washing ameliorate the soldier's condition in peace time, and everywhere the necessary measures are taken to ensure him this benefit. But then baths become an absolute necessity during a siege or blockade of a certain length, if it is desired to prevent skin epidemics brought on by personal uncleanness.

In the case of a place being besieged in winter, warm baths must be set up for the garrison. There is no need to have a comfortable establishment for this purpose. Dye-works or other convenient places may be utilized, or even locomotives if need be.

The baths may be entrusted to a civil administration, but under control of the board of health, which will not interfere with the presence of an Officer and military doctor, when a detachment comes to bathe.

IV. *The Communications in the Town, and in the Girdle of Forts.*

All the communications (streets of the town, railways, and navigable waters), as well as in the interior of the town, as outside, between the enceinte and the forts, have a great importance as regards the defence of the place.

1. *The Streets of the Town.*—In general, the streets of the interior of the town will only exceptionally suffer any alteration in case of war. In certain instances it may be necessary to demolish some buildings, which narrow the streets or form an obstacle; it may be needful to widen the streets which run along the ramparts, when they are narrowed and crowded with buildings. This widening gives greater freedom of movement to the troops, and it frees the men on duty on the ramparts from the chance of stones flying when struck by projectiles, falling near them.

It is necessary besides, to demolish all the roofs of the houses in the streets alongside the ramparts, so as to avoid the burning of the houses. Military history gives numerous examples of the miserable consequences, and even of surrenders, caused by the conflagration of these houses.

As to taking up the paving of the streets, the advantage of this operation will almost always be dubious, while on the other hand grave inconvenience may result. Indeed, streets of which the paving has been taken up, very soon become impracticable, and are very difficult to keep clean. Now the practicability of streets has always great importance with regard to the defence of a besieged place, whether as regards the promptitude with which reinforcements may be pushed up to the help of the defenders, or the convenience and ease with which things may be transported as well as the rapidity with which help may be brought in case of conflagration.

2. *Railways in the Town and in the Rayon of the Fortress.*—One of the means which may reduce very considerably the number of workmen, as well civil as military (a number which in certain places amounts to 5,000 per diem, and may increase in fortresses of the present time), consists in the employment of railways for transport purposes.

The diminution of the number of workmen will make itself felt, above all, by constructing in the interior of the place, railways or tramways which put the dépôts of *matériel*, the various magazines, the parks and arsenals, in communication with the works attacked. It will be advantageous to construct three of these ways, that of the centre leading direct to the foot of the ramp of the front attack, and two others along the gorges of the collateral works. One of these latter will cross the ditches, so as partly to supply the exterior with all necessary war *matériel*. This is why it will be useful to prolong this way to the gorge of one of the detached works. These latter will be connected by a tramway parallel to their gorges, placing them in communication with the establishment of the place above mentioned. The girdle of railway just mentioned should be constructed naturally before the period of arming the forts, and indeed, when possible, at the

same time as the forts. If the inequalities of the ground hinder the construction of this line, each large fort must be connected directly with the main work.

The lines leading to the advanced works should be traced so as not to be enfiladed. They will be protected against oblique fire by natural undulation of the ground, or masks in form of glacis.

The railways connecting the forts with the place, should be taken into serious consideration. Indeed, if these forts have to undergo a regular attack, or if they interpose as collateral works in such an attack, the railways in question allow of the theatre of the fight being supplied with all the disposable means at the proper time, and at all periods of the siege.

Von Kamptz cites as example the use made by the French at Paris and at Metz of the existing railways. He recalls amongst other things the employment of blinded batteries on trains. These trains were composed of a locomotive and one or several blinded waggons, each carrying a gun able to fire in all directions. These trains were pushed forward as far as possible, and bore the firing of their guns.

The construction of the tramways in the interior of the place, joining the fronts attacked with the various establishments, may be put off until the point of attack has been well determined. The construction of these ways should in consequence require as little time and work as possible. The author on this head gives an experiment he had made, of which the result was that depressions of ground about 2 metres in depth, may be crossed on pieces of wood crossing each other, sunk into the ground and giving a section of 33 centimetres square.

For all the tramways above mentioned, it will be convenient to employ horses as the motive power, in order to avoid the danger of conflagration from the locomotive, and to hinder the enemy from knowing the direction of the tramways by the steam and smoke given off.

The construction of these tramways belongs to the engineer department, and the train as well as the artillery will supply the horses. The *personnel* necessary for its surveillance, its maintenance and working, will be provided by the *personnel* of the existing lines, organized militarily in time of peace.

The existing railways will always be utilized as far as possible.

3. *Navigable Waters*.—In maritime places it is naturally the national or a friendly fleet that keeps up the communication with the exterior as soon as the investment is complete on the land side. Moreover, war vessels take an active part in the defence.

Numerous examples taken from military history prove that in the defence of a maritime place, great advantage results from remaining masters of the ports and maintaining communication between the port and the town, as well as being able to count on the help of the fleet: the garrison and inhabitants should not shrink from any sacrifice to ensure its preservation, since the supply of munitions of war and food depends on it.

To remain masters of the port, a service of surveillance should be

organized, by creating, at need, a small flotilla; this will be composed at least of a small guard boat and six to eight gunboats.

In default of a fleet, to defend the entry to a port, there should be no hesitation in sinking some vessels to prevent access. It is well understood in addition, that besides the port, the communications joining it to the place must be seen to.

Let us consider what part the navigable waterways should take in continental fortresses.

A navigable waterway will often be the only way that remains to the defender of communicating with the exterior; for at the commencement of the siege, the enemy will rarely be possessed of the means of breaking these communications. But this waterway should be closely watched by the besieged garrison, so as to prevent the enemy obtaining access into the place by it.

It is necessary, as far as possible, to hinder the navigation of the enemy by means of barriers and torpedoes. These obstacles naturally will be placed under the guns of the place, or at least can be defended by gunboats, unless the enemy can destroy them or turn them by digging a lateral canal.

If the garrison is numerically so weak as to keep on the absolute defensive, the barriers, of whatever nature (sunken boats, chains, torpedoes, &c.) should never be beyond the effective range of the place. In this case, very disadvantageous for it, the defence will be obliged to give up using the waterways for making sorties, or for flanking the front of attack. But in general, navigable waterways offer great advantages to the defence. Military history gives numerous examples where they have played a preponderating part.

Torpedoes for sorties may be organized with the means of water transport at disposal. Some boats should even have guns. Steamboats will above all give most valuable aid.

Among the inhabitants of the country, the *personnel* necessary for working the steamers and barges of all kinds will be found.

4. *Balloons in connection with the Defence of a Fortress.*—General Von Kamptz commences by giving a history of this question, recalling that the French were the first, in 1794, to use captive balloons to make reconnaissances, a special detachment of *aéronauts* was charged with this duty, which worked with success at Maubeuge, Charleroi, and Fleurus in 1794. Later the use of balloons for military operations completely disappeared, and it was not till the Siege of Algiers, in 1830, that the French wished again to have recourse to them, but without success.

During the Italian campaign at Solferino, the French found out the Austrian dispositions by means of a balloon. In the American War of Secession, the Southerners used captive balloons with great success before Richmond.

Captive balloons may be of great service to the defenders as well as to the attackers. In a siege the initiation belongs almost always to the besieger. The attacks of the latter surprise the defender, who is rarely in a state to oppose them in time with all requisite forces. This would not be the case, if, by observations made from a captive

balloon, whose range of view is not limited by woods and heights, the defender could gain exact intelligence as to the force, position, and movements of his adversary, as well as the resources at his disposal for the attack. Ignorance and uncertainty would no longer be on the defender's side, the rôles would be inverted; the initiative of the offensive attacks would belong to the defender who could undertake them with some chance of success.

It is then indispensable to possess a captive balloon in a besieged place; the service should be taken by the engineers. In clear weather, the range of view of an observer placed at a height of more than 3,000 metres extends to a great distance, and the most insignificant objects can be clearly seen. The balloon gives a very small and elevated object to fire at, besides, by changing its position and taking some precaution, the effect of firing is not to be dreaded.

The observations made in a captive balloon can be transmitted in three ways:—1. By a visual telegraph, by making signs with flags, &c.; 2. By means of notes written on strong paper, weighted with lead and sliding down a cord; and 3. By the electric telegraph, by placing in the car a Morse apparatus connected by a metal wire with the terminal station.

During the Siege of Paris, 1870-71, the French not only employed captive balloons for reconnaissances, but also free balloons to communicate with the exterior.

The German troops often fired at balloons leaving Paris, from guns constructed by Krupp expressly for this purpose, but the result was almost *nil*. Indeed, it will always be very difficult to hit an object so small as a balloon floating in the air, moving very rapidly, and able to rise rapidly to a height beyond the range of projectiles.

Free balloons may be used with advantage to leave a place, but as long as means of directing them have not been invented, it will not be possible to use them for entering into a place or for sending in intelligence.

5. *Carrier Pigeons (the Pigeon Post)*.—The attachment pigeons have to their birth-place is well known. The result is, that after being taken away from their homes, they do not fail to return to their pigeon house, and they are endowed with a marvellous instinct for discovering their homes, even at the greatest distances, and at a speed of 35 kilometres an hour.

This valuable faculty belonging to pigeons was known to the ancient eastern peoples, who utilized it for sending letters. Up to the period of the invention of the electric telegraph, this means was employed by bankers to announce, by winged messengers, what we now call the state of the Exchange.

In addition, history teaches us that for a long time, carrier pigeons have been used in military operations. We will specially note their employment during the Siege of Paris.

The bankers' despatches were formerly very short, written on silk paper and tied under the wings, which interfered with the motion of the pigeon and caused it to try and peck it off.

At Paris circumstances necessitated sending despatches of much

greater length than those of the merchants, but, however, the dimensions of the pieces of paper could not be increased.

M. Steenackers, Director of Post and Telegraph, then had the brilliant idea of reducing these despatches by photography, so as to hold 70,000 words on one of these papers. In order to decipher these reduced despatches, recourse was naturally had to a strong magnifying glass, which, besides, had the advantage of preventing its being read by the naked eye. The method of attaching it consists in placing the despatch in a quill tube, which is fixed to one of the feathers of the pigeon's tail.

The Parisians had not foreseen, before the investment, that they would be obliged to have recourse to pigeons, to correspond with the exterior. Thus, these pigeons had to be sent from Paris by balloons by the Government of National Defence, who then could cause despatches to be sent into the capital.

The Germans procured buzzards and hawks, which certainly caused sensible loss among the carrier pigeons.

Since the war of 1870-71, the military authorities have been seriously occupied with this means of correspondence, and it must be admitted that in future all fortresses will be supplied with pigeons well trained. But it is of the utmost importance that, in a besieged place, the pigeon houses should be placed under the care of the secret police of the Governor, for the inhabitants, not well disposed, can make use of these messengers, to communicate valuable information about the state of the place to the enemy.

V. *Expulsion and Free Exit.*

At the same time that the decree declaring a town in a state of siege appears, there appears the order of expulsion. The list of those expelled, decided on by the police in concert with the municipal authorities, is confirmed by the Governor who signs it.

The lists of expulsion should comprise people without homes, vagabonds, idlers, lunatics, strangers, and travellers; lastly, those should be included who cannot supply themselves with food or fuel, unless they engage to gain their living by work.

As has been already mentioned, no hesitation must be shown in expelling those people in easy circumstances, who are known to agitate the people and foment disorder.

It will be well to advise old men, women, and children to quit the place. Nay, more, in the interests of humanity, one must always proceed radically to the expulsion of the poorer inhabitants, of the old men, and sickly people, above all in small places, which always have more to suffer from bombardment than large towns.

Expulsion becomes difficult when the town is completely invested, and the principles of right admitted by all jurisconsults, as well as the question of humanity, forbids exposing the useless mouths who have been expelled, to death by hunger between the two enemies' camps. In this case, the besieged place cannot do otherwise than take care of these unfortunate people.

It is not the same in a place situated in an enemy's country; in this

case the sending away the poorer people can be tried during the period of investment, for the besieging troops can scarcely refuse the passage to the unfortunates who are their countrymen or allies.

In what concerns the free exit from a place declared in a state of siege, the commandant should oppose it in the interest of the defence. For instance, he should not allow exit to administrators or public functionaries, to firemen, photographers, telegraph employés, &c. In fact, he should keep in the place men who enjoy some consideration among their co-citizens, the priests and doctors, as well as the workmen who have professions which can be utilized during the siege, such as mechanics, builders, carpenters, joiners, &c.

By allowing a perfectly free exit, one is deprived of the services of persons who can exercise a certain influence on the people, and rekindle their enthusiasm; while allowing the rich to leave, would cause the poor to make reflections hurtful to the interests of the defence.

VI. *The Functions of the Governor and Commandant of a Place in a state of Siege, and of the Personnel required by them.*

I. *The Governor.*—As soon as the state of siege is declared in a fortress in a state of defence, the Governor (Commander-in-Chief) exercises the dictatorship in the name of the Chief of the State, and his authority extends over the civilian population as well as the military element. This dictatorship over the fortress, the town, and its environs, confers on the Governor rights and duties so numerous and extended, that it is impossible for him alone to cope with the task.

Besides he ought, in the first place, to direct the military operations of the defence. This exacts so much time, energy, and work, intelligence, and force of character, that, besides the commanding artillery and engineer, the senior Officer in the place has been placed on his Staff.

The organization of the work should be such as to leave all details to the Governor's deputies; he will only intervene personally in the various branches of the service in order to exercise the supreme direction, and decide finally, after having been given a personal opinion by his assistants.

The senior infantry Officer, the commanding Officer of artillery, and Commanding engineer, are the three members of the limited council of defence, and individually responsible for the preservation of the fortress. They determine on the plan of defence, under the direction of the Governor.

1. *The Senior Infantry Officer of the Fighting Troops.*—This Officer is the first assistant, and naturally the deputy of the Governor. He directs all the offensive operations of the garrison, and in particular all enterprises, with the aim of hindering the enemy's march, and defending the approaches, as well as all sorties. He determines on, with the aid of the Commanding engineer, the disposition of the infantry posts to guard the works, when this has not been done beforehand, and modifies it, meeting the demands of the commandants of the sectors, when those have found it necessary from experience.

He exercises his command specially over the infantry for sorties, over the batteries for sorties, and of the cavalry of the fortress.

The Adjutant and orderlies of whom he may have need are furnished by the combatant troops; he chooses among the inhabitants his clerks and draughtsmen.

2. *The Officer Commanding the Artillery of the Place.*—He is the Governor's right hand for all tactical and technical questions concerning the artillery.

With the view to an attack in force, he should study the measures to be taken for the arming with firearms and engines of all kinds, as well as for lighting up the ground in front, both at a distance and close to, utilizing the plan of armament already elaborated in peace time.

He tells off the number, calibre, and emplacement of the guns and other engines called into play for the defence against regular attack; he assigns to each piece its rôle in the fight. He determines on the fire orders for all kinds of firing, so as to prevent waste of ammunition, and he directs the replacing of the latter as expended. He fixes the time when the artillery fight should commence, and tells off in advance the number and calibres of pieces to be kept in reserve for the last moments of the defence.

He orders the exchange of pieces and engines which are disabled, reinforces the armament, or limits it for the time being.

It needs not to say that the commanding Officer of the artillery makes numerous reconnaissances, so as to find out the intention of the besiegers, and to prepare to meet them.

All projects or all measures which he judges necessary for the artillery defence should be seen by the Governor before being transmitted for execution to the senior artillery Officer. When the Governor is engaged, and the case is urgent, the commanding Officer of artillery has it carried out directly. In addition, he watches the proper execution and interpretation of the orders given by the Governor, as to what concerns the artillery, and he causes to be rectified on his own responsibility false dispositions made, reporting it to the Governor.

Lastly, the commanding Officer of artillery of the place keeps a journal of defence, in which he enters the expenditure of the guns, engines, and ammunition. He keeps it up, so as to be able to give each day to the Governor exact reports on the state of the *matériel*.

He has under his direct orders:—

1. The administration of the *dépôt*, of which he is the chief.
2. The *dépôt* company of workmen.
3. All the means of transport in connection with artillery.
4. The principal laboratory and all the special laboratories.
5. The *personnel* of the artificers and of the laboratories.
6. And if he requires it, of the hasty preparation of powder or gun-cotton.

To aid him in directing the different services, he has:—

An Officer of artillery, as Adjutant.

A technical Officer.

A chief artificer.

He chooses from the dépôt company of workmen, his clerks, draughtsmen, accountants, as well as two orderlies.

3. *The Commanding Engineer of the Place.*—In the first part, the attributes of the commanding engineer have been given at length.

He has under his direct orders:—

1. The Officers in charge of the fortifications.

2. The company of workmen for the fortifications.

We will not repeat the hints given, on the subject of the *personnel* that the Commanding engineer requires, to carry out properly the duties, as important as numerous, that fall to him in the defence of a fortress. We will only here remark that the question of drinking-water which he has to provide has a direct influence on the question of subsistence.

The Commanding engineer fulfils, as regards the senior Officer of the engineers, the same *rôle* that the Commanding artillery does to the senior Officer of artillery. He has the same duties as regards the proper interpretation and execution of orders, as well as the projects or measures relating to the work of defence.

He keeps, in the same way, a journal of the defence relating specially to the engineer works.

One particularly important function that falls to his lot during a regular attack, at the present time as formerly, is the daily reconnaissance of the terrain of attack.

4. *The Officers of the Staff.*—One of these two Officers collects each day all the reports that have been brought in, examines them, and submits the conclusion of this study to the Governor: he signs his report and places it in the secret archives.

This Officer has under his orders all the observatories of the steeples, the captive balloons, and their *aéronauts*. He makes out the correspondence in cypher; for this purpose there is attached to him a sworn decypherer, who is at the same time the secretary of the two Staff Officers.

The second of these Officers has charge of the news collected from explorers, spies, secret police, and the pigeon post. He is the censor of the press, and draws up all official articles, intelligence, invitations, defences, &c., which the Governor thinks necessary to publish.

5. *The Adjutants.*—The senior Adjutant looks after the reports and the situation of the combatant troops, and tells off the duties.

He makes out the orders for the troops and directs the telegraph service of the fortress, of which he has all the officials under his orders. In addition, he has charge of the correspondence with the commandants of sectors and the heads of corps.

The second Adjutant keeps up the daily journal of the Governor, in which are entered all the military dispositions taken for the safety and defence of the fortress, as well as all events that may influence the defence. For this reason he has charge of the correspondence with the civil authorities.

The *personnel* employed in the Governor's offices consist of two secretaries, two telegraphists, two draughtsmen, and six clerks, without counting the necessary orderlies.

The following can naturally be relieved only by the Governor's orders:—

1. The commandants of sectors.
2. The commander of the general reserve of the place.
3. The commanding Officer of the garrison artillery.
4. The commanding engineer.
5. All the chiefs of corps placed under the direct orders of the senior infantry Officer.

In all questions not directly concerning the military defence, the second commandant is naturally the deputy of the Governor. The great fortresses have, from the end of peace, a second commandant.

II. *The Second Commandant (Stadt-Kommandant).*—The business transacted by the above may be classed under two great heads—military and administrative affairs. His sphere of action does not extend beyond the enceinte of the place.

The military part of his duty is concerned with the service of the guards of the interior of the place. The author lays down that the numerous guards cannot be furnished by the combatant troops without exhausting them and reducing their effective numbers. From this results the necessity of forming garrison companies with the invalid soldiers of the town and environs, who will be formed in battalions of four companies.

Officers retired or on half-pay will be told off to command these troops, whose recruitment, according to the author, will not present any serious difficulty.

These companies will then have charge, along with the armed men of the companies of workmen, of the guards of all the establishment, powder mills, parks, prisoners, &c., as well as furnishing the employés in the offices and orderlies.

The administrative part includes various indispensable services, having as common aim the safeguard of the entire garrison. The following list will explain the number and importance of the services under the command and control of the second commandant:—

1. The treasury.
2. The supply.
3. The administration of the garrison.
4. The gasworks.
5. The police of the fortress.
6. The fire brigade.
7. The hospital.
8. The company of stretcher bearers.
9. The military prison.
10. The prisoners of war and prisoners of the fortress.
11. The disinfecting arrangements.
12. The burial of the dead.
13. Divine service.
14. Administration of martial law.
15. Requisitions.

This long list shows the necessity of relieving the Governor from all the administrative work. The various services should doubtless be regulated as regards details by their special heads. Military history shows besides that it is necessary to exercise a minute control over

those employed in the administration, and to bind their lot indissolubly, so to speak, to that of the fortress.

It is then quite reasonable to subordinate all these employés to the authority of the second commandant and his assistants, the only way of impressing in the interest of the defence a single impulse to all the parts of this great war machine, and to watch that nothing is lost or is altered, or gets spoilt from narrowness of mind, negligence, or indolence.

The second commandant has need of several assistants to carry out his duties well, half military, half administrative.

His first assistant and deputy is the president of the board of health, and after him the first permanent member of this board. The second is also a superior Officer. He is also assisted by the town Major, two Adjutants, and by the senior Officer of the intendance.

1. *The President of the Board of Health.*—To occupy this post a superior Officer (retired or on half-pay), active and energetic, is chosen. As we have already mentioned the president has under him :—

1. The housing of the troops.
2. The hospital.
3. The provisions, &c.
4. The feeding of the soldiers (canteens, &c.).
5. The employment of disinfectants.
6. The company of stretcher bearers.

The delivery of provisions is carried out, according to arrangements made by the board of health, under the chief of the commissariat, and a senior combatant Officer.

The board also settles or rectifies the tariff regulating the merchants, retailers, and victuallers, who sell food to the troops. It has charge of inspecting the state of particular provisions.

The first assistant of the president of the board of health, permanent member, and vice-president of this board, is a Lieutenant-Colonel or Captain (retired or on half-pay).

He has special charge of inspecting and controlling :—

1. The stretcher bearers, and the places for dressing wounds.
2. The lavatories and bathing establishments.
3. The merchants, hotel keepers, and victuallers.
4. The canteens of the garrison companies, and the companies of workmen.

The second assistant is the chief purveyor of the garrison. He is directly under the orders of the president. He has charge of verifying the good quality of the food and provisions; he should submit the medicines supplied to a careful analysis. With the president he sees to the good quality of the medicine in the hospitals, he inspects and controls the disinfection of articles of equipment of the hospitals, barracks, private houses, and drains.

The chief purveyor should be an inhabitant of the town or suburbs, and have the reputation of being a well-informed and honourable man.

2. *The Town Major.*—He tells off according to roster the guards and patrols, the police, the firemen, &c. He warns witnesses for courts-martial, &c.

He inspects and controls all that is connected with the service of guards.

He exercises special authority and control over suspected people, and those in confinement, as well as prisoners of war, and the houses of detention. He has all the turnkeys under his orders.

He sees to the burials, and has charge of the communications with the clergy.

3. *The two Adjutants.*—These are also Officers (retired or on half-pay). One exercises control over the police of the fortress, the civil police, the fire brigade, the gasworks, and the lighting of the streets, public places, and buildings.

The other directs the offices of the place. He makes out the intelligence, the reports and proposals to be submitted to the Governor. He has charge of arranging affairs with the municipal authorities. He makes out requisitions. Lastly, he keeps the journal of the second commandant.

4. *The Chief of the Intendance.*—He inspects and controls all deliveries and supplies of clothing and made-up material for the troops, hospitals, and prisoners. He inspects all the magazines, including those in charge of the troops. All paymasters and accountants are under his orders as regards their duty.

He passes all purchases for supply of clothing and materials, subject to the approval of the second commandant, his direct superior.

5. *The Officer in charge of the Treasury.*—He has charge of the books and chest of the fortress, as well as of effecting payments according to orders in force.

The ordinary inspection of the chest is made once a week, but casual inspections can be made by order of the second commandant.

In case of want of cash, the Governor procures it by one of the means mentioned in the course of this work.

6. *The Garrison Judge Advocate.*—Not only are the military and functionaries amenable to courts-martial, but also all those who disobey orders given by the military authorities, who force sentries, who take advantage of the soldiers to whom they sell food, who excite discouragement or discontent, or do prejudice in any way to the defence of the fortress.

For these various services accruing to the second commandant, there are necessary 3 secretaries, 2 in charge of archives, 8 clerks, 9 orderlies, 1 cashier, and 1 messenger of the court. All the orderlies are given by the garrison companies.

7. *The Principal Medical Officer of the Garrison.*—The principal medical Officer must be relieved, as far as possible, from all secondary affairs, so as to allow him to devote himself entirely to his professional duties. He has to direct, inspect, and control the duties of all the medical officers and inferior *personnel*, as well as of all the hospitals and ambulances. He has the disciplinary powers over all the *personnel* of the medical branch, corresponding to the rank he occupies in the service.

To help him in his duty, an assistant medical Officer, a clerk, and an orderly are told off.

As a member of the board of health, the principal medical Officer attends all sittings in which questions referring to his department come up. On his demand, the president places, for the time being, at his disposal, the principal purveyor, for the control of the purveyors.

The president of the board of health has, in addition, the right and the duty of controlling the duties of the principal medical Officer of the garrison, particularly as to the following points:—

1. Never to allow the soldiers in hospital to be made the subject of experiments as to medical treatment or surgical operations, in the interests of science.

2. Never to allow the sick to be maltreated, and to insist that the inferior employés shall respect decency and morality.

3. Never to allow damaged medicines to be issued to soldiers under any pretence.

4. Not to allow the soldiers of the garrison to be hindered, without cause, from visiting their comrades in the hospitals.

Here it may be remarked that the right of the company and superior Officers to visit their men in hospital must be respected. It is the duty of an Officer to take care of his subordinates, and look after their welfare, and it is by such means that the Officer gains the confidence of the soldier.

The Clergy in a Besieged Fortress.—As a proof of the care with which all has been foreseen and regulated, as regards a state of siege, the author even proceeds to give a list of texts from the Bible, which he recommends the clergy to use. The clergy will always exercise considerable influence on the people. Therefore, the attitude they take during a siege cannot be a subject of indifference. The Governor should be informed on this head, for it is easier to combat an open enemy than a hidden one, who hides his secret thoughts under the mask of friendship.

At the commencement of the siege, ministers of all persuasions will be summoned by the commandant of the town, in the name of the Governor, to allude to the state of the town in their first sermon, and to inculcate to their flocks blind obedience and submission to the high military authorities of the fortress and town.

They will be requested also to make public prayer for the troops employed on duty and in the defence of the place.

The author here gives the texts that the clergy must use for two sermons to be preached.

After these two sermons, preached on given texts, the Governor will easily see if the sentiments of the clergy are patriotic or not.

He will also impress on the clergy, whenever he meets them, the duty of visiting the sick and wounded.

Of course each minister must have free access to the hospitals and surgeries for dressing wounds, as also to the prisoners: a permit will be given to each by the commandant of the place.

The clergy should address their propositions to the second commandant, who decides when it is competent for him to do so, or asks the decision without appeal from the Governor.

VII. *Essay on the Organization of the Services of Keys in a Place in a State of Siege.*

The author finishes his work by an essay on the organization of the service for the numerous keys, of varied form, which are in a strong place, because it often happens that in full daylight, the employés can only find the required key after much loss of time. He cites numerous examples, where the besieger has succeeded in entering the works of the place at the same time as the repulsed troops of the besieged, because they were not able to close the gates of communication.

It is very certain that much order and method are required in the division of the keys, in order that they may be always to hand, to open or close the passages, gates, bridges, barriers, reduits, block-houses, guard-houses, caponiers, batteries in the ditch and reverse batteries, subterranean communications, dams, posterns, mouths of sewers, gratings, battlements, &c. But these are the dispositions particularly concerning the staff of the place, and which, for this reason, are not given here.

The author recommends different forms of labels for the keys of the various parts of the works, and remarks that the metal for these labels should be easily lit up in the dark. He enters at length into the various forms of keys, as to wards, handles, &c.

He then considers the custody of the various keys.

A. The artillery dépôt keys.

1. An Officer has the keys of the main powder magazine for keeping loose powder in casks for issue to laboratories, &c.
2. A second Officer has the keys of the main powder magazine for storage of made-up ammunition, &c., for issue.
3. A third has the keys of one of the small fuze magazines.
4. A fourth has the keys of the rooms where loaded shells are stored.

B. The laboratory department keys in charge of the chief Officer.

1. The main laboratory.
2. Special laboratories in the forts and detached works.

C. The commander of the garrison artillery keeps the keys of—

1. Expense powder magazines.
2. Shell filling rooms.
3. The falling barriers in wall embrasures.

D. The commandant of each sector of the fortress and of each fort hands to his Officers the keys of—

1. To the reduit and defensible buildings.
2. To the ditch caponiers, ditch and reverse batteries, to the loopholed walls and bonnet casemates.
3. To the block-houses.
4. To the defensive barracks and defensible buildings. The Captains of companies receive the keys of the barrack casemates.
5. The commandant of the sector himself, as also the commander of each fort, keeps the keys of the entrance gate and passages, which might endanger the place if left open.

They are—

- a. To the inner and outer main gate, as also to the small wickets, which are in one leaf of each door.
- b. To close the falling barrier on the bridge.
- c. To the barriers of the tambour in front of the bridge of the ravelin.
- d. To the wicket of the enceinte and flying bridges over the ditches, where such remain open, in the interest of the defence.
- e. To the inner and outer gates of each postern, as well as the key of the wicket of the inner gate.

All these remain in the custody of the commandant of the sector, who gives the key to the passages from the ravelin to the ground in front to the Officer commanding in the ravelin.

These keys, while the two commandants are held responsible for them, are actually kept by non-commissioned officers told off for this purpose, and called "key majors."

E. The commanding Officer of pioneers keeps the keys of—

1. The torpedo magazine.
2. The magazine for mining explosives.

F. The commanding Officer of miners keeps the keys of—

1. The mine galleries.
2. The subterranean communications.

The organization just given, says General Von Kamptz, gives a definite responsibility to each of the authorities in the fortress charged with the defence of the place and the administration of the town. Thanks to this organization, thanks to the creation of garrison companies, of companies of workmen and sick bearers, thanks to the happy dispositions made with regard to the artillery and engineers, the soldier and townsmen will firmly believe in the durability of the resistance. This confidence, which can only increase in view of the minute measures of precaution taken for the defence of the place, can only engender in the one and the other the conviction that the place will resist. And if this conviction is deeply rooted in the hearts of the defenders, success will not fail to crown their efforts.

This work is the product of historical research and laborious compilation, added to great experience on the question considered. The author has collected and grouped a great number of facts scattered through numerous treatises.

MOUNTAIN WARFARE.¹

"Der Gebirgskrieg," von FRANZ FREIHERN VON KUHN, k. k. Feldzeugmeister. Mit 3 Karten.

LIEUTENANT-GENERAL THE BARON VON KUHN is too well known, both as a leader in the field and as an army administrator, to require any introduction to the readers of this Journal. Still it may be well to remind them that he distinguished himself in command of the forces which

¹ Published at Vienna by L. W. Seidel and Son. 1878. Size 9½" × 6½" × 1". Weight 12¼ ozs. Price 10s. with plates.

defended South Tirol against the Italians in 1866, gaining at that time practical experience in the branch of warfare to which he appears to have specially directed his attention in earlier times.

The events of 1866 convinced the Court and Government of Austria that a thorough reform and reorganization of its military system were absolutely necessary, but in such a country it would have been difficult, if not impossible, to find amongst the aristocratic Officers then occupying almost all the highest positions in the service anyone sufficiently untrammelled by class prejudice and family connection to carry out the sweeping changes which were manifestly required, and some of which were highly distasteful to the nobility. The first steps in reform were indeed taken soon after the war under the auspices of the Conqueror of Custoza, but the task of carrying these reforms to their extreme point, of putting the high-born Officer on the same footing with his more plebeian comrade, and, in short, of completing the organization which transformed the Austrian army into a really national force, devolved upon von Kuhn, who was appointed War Minister in January, 1868, retaining that office till June, 1874, when he fell a victim to the party whose prejudices he had offended, after having, however, during his six years of office, accomplished a work which ensures him a place in history. He is still, though past sixty, full of vigour, both mental and physical, and enjoys the confidence of the army. Should Austria be again involved in war within the next few years, the world will probably hear more of Baron von Kuhn.

Meantime the slight sketch which I have given of the latter part of his career is sufficient to show that the views of such a man deserve attentive consideration, especially upon a subject to which he has devoted much thought. Moreover, an Austrian Officer has special advantages in the study of mountain warfare, as the military history of his nation contains more examples of it than that of any other European Power. Her geographical situation is such that it would be hard to mention any war in which Austria has been engaged and in which the neighbourhood of mountains has not exercised, either directly or indirectly, a powerful influence. When fighting against Prussia the mountainous districts of Saxony, Bohemia, and Moravia have been the scene of many a struggle. Again, in her numerous conflicts with France and Italy the Alpine region has always formed part of the theatre of war and has influenced the operations of armies manœuvring in the valleys of the Danube and of the Po, even when not itself the scene of important engagements. Nor have the events of recent history diminished the probability of the employment of Austrian troops in mountain warfare; for though the loss of Lombardy and Venetia has perhaps made it less likely that the Alps of Tirol should again become a fighting ground, and though there seems to be very little probability of French and Austrian armies again coming into collision amongst the Swiss glaciers, yet, on the other hand, the occupation of Bosnia and Herzegovina has provided a new border province of a mountainous character, and the Carpathian chain seems destined sooner or later to be the scene of conflict whenever the two great Empires, whose territories it practically separates, come into collision.

Of all the principal European armies that of our own country has probably had the least to do with regular mountain warfare, the most notable instance in our history being the short Pyrenean campaign of 1813-14. Our troops have indeed at different times had plenty of fighting amongst mountains in India and elsewhere, when those engaged have undergone the peculiar hardships and gained the special experience incidental to warfare of this description, but owing to the nature of the foe, savage or half-civilized, the operations have usually been very desultory and unsystematic in character; consequently a scientific study of mountain warfare, as carried on between civilized nations, has not been much required amongst us.¹

Nevertheless the British Officer should not neglect this branch of military art, for, independently of the interest attaching to it for its own sake, he may find a practical advantage in making himself master of it, for the situation in Asia is such that there seems to be a by no means distant prospect of our being engaged in warfare with a great civilized Power where mountains will form an important part of the theatre.

The work now before us is a very useful one to study. It is a textbook in the Austrian military schools. It treats the special subject more exhaustively than any work with which I am acquainted, and though much which the writer tells us has been told before by others (and this is particularly the case in respect of the general principles of strategy), it yet contains a great mass of useful information and much valuable instruction which it would be probably impossible to find in any other single work.

Many of the illustrations taken from military history are highly instructive. It is to be regretted that they are not accompanied by maps, those published with the work being merely those to elucidate the author's principles.

A slight sketch of the general arrangement of the work may be acceptable to my readers. It has gone through two editions, the second, a copy of which is now before me, having been published last year. The author tells us in the preface to his first edition, published in August, 1870, just after the outbreak of the Franco-German war, that his treatise was finished in 1859. He does not explain why it was not then brought out, but mentions that its appearance was afterwards delayed in consequence of additions and alterations due to the events of 1866, from which period he gives some instructive examples. The manuscript thus remained in the writer's closet for nearly eleven years before publication, so that he more than acted up to Horace's advice to the would-be author—

" . . . nonumque prematur in annum, membranis intus positis "

He is not one of those writers who rush hastily into print; on the contrary, his work is the result of careful study and reflection, fortified by practical experience in the field and in the cabinet.

¹ Some of our Generals, however, have shown great capacity for conducting operations amongst mountains: witness, for instance, Sir Charles Napier, whose expedition to the Cutchee Hills, in 1845, was a model of its kind.

The text of the first edition, as we are informed in the preface to the second, is republished in the latter with but slight alteration, and only with the addition of a chapter upon the defence of the Balkan, for, says the writer, "the principles which I propounded as applicable to "mountain warfare, depending as they do upon actual fact and upon "the nature of things, hold good for all time, and their truth has been "corroborated anew by the most recent incidents of war." The work is divided into six chapters, the subjects of which are as follows:—

Chapter I. Mountain Warfare in general.

„ II. Defence of a Mountain District.

„ III. Fortification of a Mountain District.

„ IV. Attack of a Mountain District.

„ V. Defence and Fortification of Mountain-chains.

„ VI. Examples from Mountain Warfare.

In the first four chapters will be found, first, a statement of general strategical principles, with reflections thereupon; secondly, remarks and instructions, sometimes in great detail, upon military training and education, upon tactics and fortification, upon transport and supply, upon organization, equipment, and means of communication; thirdly, examples taken from actual warfare and bearing upon the author's theories. Naturally enough a large proportion of these examples is taken from campaigns in the Tirol.

Chapter V contains, amongst other valuable matter, an interesting description of the line of the Balkan, together with the author's views as to the proper mode of defending it. This was evidently written before the Russians crossed the Danube in 1877, and it is to be regretted that we have not the author's remarks upon that event and upon the subsequent incidents of the campaign.

In the same chapter will be found a carefully written treatise on the "strategical value of the theatre of war on each side of the Carpathians," a subject of peculiar interest to the writer's countrymen.

Chapter VI is devoted entirely to some additional examples from actual warfare amongst mountains, those chosen being—

1. The Campaign of Rohan in Valtellina, 1635.

2. The Defence of the Eastern Pyrenees by General Riccardo, 1793.

3. The Defence of Northern Tirol in the first half of November, 1805.

4. Dispositions for the Attack of Pergine and Levico, August 2, 1866.

Baron v. Kuhn is evidently of the same opinion as Jomini (who, by the way, cites the first of the four examples given in this chapter), that, "*l'histoire bien raisonnée et bien présentée, voilà la véritable école de la guerre de montagne.*" The same remark indeed holds good of every kind of warfare. What mere study can be so good a preparation for war as that of military history?

I will not attempt to give a précis of the contents of the several chapters, but will make a few remarks upon some of the writer's conclusions, and upon some points connected with his theme which appear to me to have peculiar interest.

"Both the attack and the defence of a mountain region are " amongst the most difficult tasks which can devolve upon a General." Thus commences General von Kuhn's treatise, a great part of which is taken up with a comparison of the relative merits of offensive and defensive action when applied to mountain warfare. When dealt with in the abstract by writers who treat of war generally, each mode of action has its supporters, for each has incontestably its advantages and its disadvantages. Von Kuhn considers that the latter are greatly intensified in mountain warfare, both for the attacking and defending party. Indeed, so great are they, that "we meet with very few cases " in military history where the defence of a mountain region has " fully succeeded; on the other hand, where the defender makes the " most of his advantages, knows the ground well, and makes energetic " counter-attacks, the assailant will encounter almost insurmountable " obstacles."

It would appear from this passage that the author finds it hard to choose between offensive and defensive. However, we find further on the following conclusion:—"It appears from the comparison which " we have made of the advantages and disadvantages of the *offensive*, " that the attacking General who has both the ability to plan and to " execute whilst providing plentifully for the supply of his army, and " who has also the moral and physical power necessary to enable him " to cope with all difficulties, must always possess an undoubted ad- " vantage over the defender, and that should the latter confine himself " to strictly defensive action, he will inevitably meet with disaster, as " history sufficiently proves."

Jomini is less convinced of the superiority of the attack over the defence, but holds the same views as to the necessity of combining the offensive element with the defensive, as the following passage from the "Précis de l'Art de la Guerre" will show:—"Ces événements" (the campaign of 1799 in Switzerland) "semblent donc prouver que si les " pays de hautes montagnes sont favorables à la défense tactique, il " n'en est pas de même pour la défense stratégique qui obligée de se " disséminer doit chercher un remède à cet inconvénient en augmentant " sa mobilité et en passant souvent à l'offensive." A merely passive defence is dangerous and likely to end in disaster under all circumstances, but this is especially the case in mountain warfare, where also disaster is likely to be more complete than in the plains. The defender must therefore seize every opportunity of taking the offensive; but "to do this at the right moment is one of the most difficult tasks " which falls to the lot either of Commander or of troops," says von Scherff in treating of the "Defensive-offensive;" and if difficult in the plain, it must be much more difficult amongst mountains where a Commander must find it very hard to get a clear idea of the general situation, and where rapidity of movement, so essential to the success of a counter-stroke, is much impeded. It, therefore, would appear that, conditions being equal, as must always be supposed when treating such subjects theoretically, the balance of advantage is with the assailant.

But, practically, we find as a general rule that the defender has one strong point in his favour, which renders the conditions unequal, and

goes far towards repairing any strategical or tactical inferiority; namely, the fact that the natives are on his side and are most valuable allies, being generally strong and hardy; moreover, accustomed to mountain work and well acquainted with the country. When in addition to this they are well armed, good shots, and organized as a militia, they will add immensely to the strength of the defending force.

The inhabitants of the plains are at a great disadvantage when first required to act amongst mountains; hence we meet with frequent instances in history of prolonged, and, for a time, successful resistance being made by irregular mountain levies against veteran soldiers. In the long run the mountaineers have been overpowered unless supported by regular troops; but a very small proportion of the latter, acting as a reserve to the native militia, has sometimes been sufficient to repulse a much larger force of invaders. The work before us contains several examples of this nature taken from the history of Tirolese warfare.

The author is strongly in favour of giving special training in peace time to troops intended to act amongst mountains, and makes many practical suggestions to ensure their efficiency.

Firstly, that in order to get both man and horse into proper condition, troops should be frequently exercised amongst the mountains in complete marching order, the Officers taking note during these marches of the time required to get over a certain distance on various kinds of ground, a thing only to be learnt by experience.

Secondly, every opportunity should be taken during these marches to practise field evolutions suitable to the special conditions of mountain warfare, and particularly to train subordinate Officers and non-commissioned officers, for in no other sort of warfare will they be thrown so much on their own responsibility, or will their conduct so much affect the general result. "Troops," says von Kuhn, "which 'have only been trained on the plains and on the drill-ground, will be 'quite at a loss amongst high mountains, and will be of little or no 'use.'"

Both the Austrian and Italian Governments are fully alive to the importance of having troops inured to mountain warfare to defend their mountain frontiers. The former Government took steps in 1870 and 1874 to perfect the organization of the Tirolese Militia and Landsturm, which have over and over again rendered such great service to the country, and a division is occasionally assembled for the purpose of manœuvring in the mountains, composed partly of regular troops, partly of the Tirolese Militia. A sketch of the Tirolese defence organization now in force, and a short account of one of these mountain manœuvres, will be found in a paper on the "Austrian Army in '1875," printed in No. 87 of this Journal.

Volumes 13, 14, and 15 of the "*Revue Militaire de l'Etranger*" contain articles on the organization of the new "Alpine Companies," which show what Italy has been doing in this respect.

The question of dress and equipment is important as affecting the efficiency of the soldier, particularly when mountaineering. Von Kuhn recommends that the throat, breast, and knee should remain

free, the first from any tight collar or neck cloth which prevent the free passage of air, the second from cross-belt or pack-strap which impede respiration, the third from the ordinary trousers which check the action of the leg when climbing, particularly in wet weather. "The best plan is to keep the knee uncovered like the Tirolese and "Scotch, but if from mistaken notions of propriety the bare knee is "not approved of, then adopt the knickerbocker, roomy above and "tight fitting only below the knee." Anyone accustomed to mountain climbing will approve of these suggestions as to dress. Of course the kit should be as small as possible, and what is carried should rest upon back and shoulders. Waist-belts should not be worn, as they press unpleasantly upon the hips.

The haversack bangs about the legs and annoys the mountain climber; it should therefore be made as small as possible so as only to contain bread for immediate use, pipe and tobacco. Two days' bread should be in the knapsack, and I should think also a reserve supply of cartridges, though von Kuhn does not say so. He prefers shoes to boots, and of these the soldier should have two pairs, one of which would be carried under the knapsack cover. They should have low heels and broad thick soles, well studded with hobnails. I would suggest, in addition for use on the higher mountains, a pair of long woollen gaiters, fitting over the instep and fastened by thongs under the foot. These are worn by the Swiss mountaineers when wading through snow as a protection against frost-bite.

The smockfrock now issued to the Austrian soldier is recommended. It can be worn by itself in summer, and over a jersey in winter. Of course, the soldier must carry all indispensable necessities, provisions, and ammunition on his own person. Officers have hitherto had their kits carried for them on baggage carts. Von Kuhn thinks that these should be done away with. They are very much in the way, and yet seldom at hand when required. The small amount of personal baggage required by an Officer in an active campaign should be carried by his servant, we are told. But unless Officers' servants are to be considered non-combatants, this arrangement would hardly appear likely to answer, as the men in question would be overloaded. It would be better to have mules to carry Officers' baggage, say one per company, that is, one to each four or five Officers. Except with reference to the small point just mentioned the question of transport is not discussed in the work before us, probably because the author thinks that there can be no difference of opinion upon the subject.

Naturally, wherever there are practicable roads, carts or waggons would be used, principally for the purpose of filling and supplying magazines and dépôts, but as in a mountain campaign troops would often have to move far away from carriage roads, they would then be accompanied by pack animals to carry provisions, ammunition, and hospital necessities. Sometimes a corps of porters may be formed from natives of the country.

But in a mountain campaign more even than in any other description of warfare, it is necessary that baggage should be reduced to a minimum.

The decisive action of a campaign will rarely be fought amongst

mountains which will more often be the scene of preliminary operations, as in the Bohemian war of 1866 and in the Italian campaign of 1800, or else of operations of secondary importance, which only exercise an indirect influence on the manoeuvres of the principal armies, as for instance the fighting in Tirol in 1805 and in 1809.

Entire armies have occasionally to force their way through mountains, but there are few instances of protracted operations being carried on amongst them by large bodies of troops, the difficulties of direction and of supply in such a region being enormous. Moreover, the prize of victory is generally to be sought in the plains.

"Often," says von Kuhn, "a brigade will suffice for what it has to do; only exceptionally will an army corps of from 18,000 to 20,000 men be required." What should be the composition of such a brigade or corps? It will of course consist chiefly of infantry. A considerable detachment of cavalry will, however, be required to take part in the action in the larger valleys, to make sudden sallies into the plains and to perform scouting and reconnoitring duties. The following instance, given by von Kuhn of the value of even a few horsemen amongst mountains, is worthy of record.

"The attack made by eight Lancers under the brave Lieutenant Baron Torrisani on some hundreds of Garibaldians upon whom they came by surprise at the turn of a road, and whom they cut up fearfully, shows what a powerful moral effect the sudden appearance of even a small party of cavalry may exert."

It need hardly be said that for mountain warfare cavalry cannot be too light.

The artillery should principally consist of mountain batteries, though there should also be field batteries to act in the larger valleys, and in case of a sally into the plains. The mountain guns, limbers, &c., are generally carried by mules, but von Kuhn prefers horses reared in the mountains for the work, because they are more docile and more easily managed. Mules, he remarks, are specially troublesome in case of retreat downhill, hence in such a case it is necessary to limber up much sooner than is desirable in order to avoid capture. It is well to have with each mountain battery a couple of rocket stands from which you can keep up fire after the guns limber up, only carrying them to the rear with the infantry when they have retired upon you.

The improvement of the gun furnished to mountain batteries is an important question not referred to in the work before us, but one which has been occupying the attention of artillerists in many countries of late years. Their aim has been to augment the range and accuracy of the piece, and at the same time to increase its portability. The result has been that new mountain guns have been adopted into the service by Austria, by Switzerland, and by Great Britain. That of the last-named Power is the most remarkable of the three, being divisible into segments to be carried by pack animals. We have yet to see how it will answer in the field.

Von Kuhn does not include any engineers amongst the troops of his mountain column, but he would certainly not omit a detachment of

that corps were he preparing to take the field, as he cuts out plenty of work for them in the shape of fortifications, not to mention what they would have to do in the way of repairing or destroying roads, bridges, &c.

Having now, we will suppose, trained Officers, men, and horses for mountain warfare by plenty of preparatory practice, having armed, equipped, and organized them as seems best for the special work, the last but not least important task is to supply them with a leader. The author's remarks upon this point appear to merit especial attention:—

“ As a leader in a mountain campaign you must choose “ a man who has plenty of the offensive element in his composition, “ who possesses indomitable energy and endurance, who is accustomed “ to mountains, and who understands the nature of mountain warfare.

“ Independent action should be instinctive to him. As he may “ have the power of greatly influencing the operations of the main “ army, he should understand the great principles of strategy, so as to “ be able to judge of the right moment for decisive action, and he “ should have enough foresight and prudence to give up the offensive “ when the risks become too great, and to resume the defensive. He “ should, in short, possess, though on a smaller scale, the qualities “ which characterise the great General. He should moreover be strong “ and inured to hardship, so as to bear with ease the physical trials “ inseparable from mountain warfare, allowing no material obstacles “ to daunt him, for great results are only to be gained amongst “ mountains by movements which appear at first sight impracticable.

“ If you select a Commander who is not thus gifted he will confine “ his operations to the more accessible valleys. Should then his “ opponent be one of the right sort he will give way before the other “ till he sees his opportunity, then swoop down from the mountain “ top upon the easy-going chief and make an example of him.”

A good intelligence department, a good system of scouting, of signalling and of conveying orders and information, everywhere necessary, appear to be more important amongst mountains than anywhere else, because here the very nature of the ground favours surprise both by concealing the enemy's movements and intentions, and by interfering with your own communications. These difficulties are much increased or much diminished, according to whether the mountaineers are hostile or friendly.

A well-trained signal corps is indispensable, and in ordinary weather will suffice to keep up communication between the different sections of a force and head-quarters. In very bad weather, unless there has been time and opportunity to lay the field telegraph, the only means of communication will be by mounted or foot messengers, which is a slow process, or by sound-signals, which are very likely to be misunderstood. All the more important is it that a commander should look to all roads and footpaths within his reach. The defender will generally have more time to do this than the assailant, and he should spare no pains to improve his communications. His safety may depend upon them.

Von Kuhn remarks: "Very laughable indeed is the idea which still crops up in many an unpractical head, that you should have as few good roads as possible in a mountainous district, so as to impede or even stop the enemy's advance. The enemy will not allow himself to be stopped by bad roads, and the difficulties of our defence are much increased by their badness. Allowing that a road is useful to your assailant it is equally useful to you, when you wish to take the offensive, as you must do sooner or later, if your defence is to end successfully."

Two kinds of permanent works are required to fortify a mountain region; firstly, something of the nature of an entrenched camp to occupy important strategical points, such as are found at the intersections of lines of operation with transverse lines of communication, or at a central point where several roads unite, or at the outlet of a pass from which a counter-attack may be conducted with advantage; secondly, mere barrier forts for the purpose of closing defiles and passes.

The principal object of the former class of work is to protect the defender's communications, magazines, and lines of retreat whilst he takes the offensive with part of his force; these fortifications have therefore an offensive purpose; the latter class on the other hand are purely defensive, and are constructed for the purpose of delaying the advance of an assailant, thus affording time for the defender to concentrate his forces to oppose him. The defender must not commit the error of having too many of these forts or of shutting up too many men in them, otherwise he will fall into a very common mistake, and will be adopting the vicious "cordon" system, a good but little known instance of the danger of which is given in the account of the attack of General San Martin on the Cordilleras and Chili in 1814. As the barrier forts must often be constructed of stone unprotected by any earthwork, the use of armour plating or of cupolas is recommended.

The construction of permanent works may have been omitted from want of foresight, want of time, or want of means, in which case recourse must be had to field fortification, and much may be done in a short time to add artificial strength to a position already strong by nature, and even when permanent works exist it will generally be advantageous to supplement them by the construction of temporary works as the occasion arises. The same principles would guide the defender in his selection of sites for the latter as for the former.

The Defence and Fortifications of Mountain Chains.

As this chapter has a special interest for us Englishmen both with reference to the immediate past (in Turkey), and to the more or less immediate future (in Turkey again and on our Indian frontier), I propose to enlarge upon it rather more than upon other portions of the work.

Given a chain of mountains either as the frontier between two States or as the line dividing two armies, which is preferable from the purely military point of view, to defend the line by occupying a position in front of the chain or by holding one in rear of it. I think

that if unhampered by political considerations, the strategist will certainly prefer the former position, always supposing that the forces at his disposal are not much inferior to those of his adversary, and that the nature of the country in front of the chain is not very unfavourable to an active defence.

He will prefer the former position, because the character of mountain warfare, being essentially offensive even for those on the defensive, that same forward position gives him the greatest facilities for dealing those counter-strokes which are so essential to his success. Moreover, the moral effect of holding the advanced position is great. It is at once a confession of weakness on the part of a General if in guarding the line of a river he restricts himself entirely to one bank, or in defending a range of mountains he hides his whole army behind it. Such a course may be forced upon him, but should never be willingly adopted. Setting aside, however, political considerations, with which we here have nothing to do, though practically they will always come more or less into play, there are certain local conditions of a strategical and tactical nature which should exist, says von Kuhn, in order to justify the defender in taking post in front of the mountain barrier.

These conditions, according to him, are as follows:—

“1. The general slope of the mountain range should be steeper to the front than to the rear, the base of the exterior slope being therefore shorter than that of the interior slope. The flanks of the position will thus be more secure, as each wing of the army when thrown back will more easily rest on the main ridge, and in consequence communication with the rear will be less open to interruption. Moreover, as the mountains under the conditions supposed will generally rise straight from the plain without any offshoots, the defender's offensive operations will be much facilitated.

“2. The whole width of the range should not be too great in proportion to its height, for otherwise even if the last-named favourable condition exists, the defender's base of operations will be too far from his advanced position for communication between the two to be kept up securely under all circumstances.

“3. There should be in the zone of operations itself few or no roads connecting the main line with the secondary lines of operation on each side of it, or should these exist, it should be easy to block and defend them.

“4. The configuration of the ground in the neighbourhood of the position should be such as to favour rather than to impede flank movements necessary for the defence. This will be the case if there be no detached hills in advance of the main range, in front of or on the flank of the defender's position so placed as to be vantage points for the assailant.

“5. The advanced position should also be tactically favourable, and should be proportioned to the force available for its occupation, whilst the ground about it should be suitable for offensive operations.”

Von Kuhn's conditions seem to be a little too absolute, and he himself sets us the example of departing from them, for whilst in some of

the cases cited as examples of positions in front of a chain of mountains (namely the Eastern Pyrenees and the Eastern Apennines, fronting to the north, and the Alps fronting to the south), the said conditions prevail, some of them at least are wanting, in the case of the Balkan chain fronting to the north, which however, after describing at some length, he maintains to be eminently suitable for defence from an advanced position. Yet, as a rule, the southern face of this chain is more precipitous than the northern face, and the range does not rise abruptly out of the plains on the side of the enemy; on the contrary, along a great portion of its northern front there are many spurs and offshoots and a tract of broken country intersected by streams and valleys running perpendicular to the general front, and much impeding offensive action from the advanced flanking position which the author recommends and which was indeed occupied by the main Turkish Army in 1877.

After a somewhat minute description of what was at the time he wrote on the point of becoming a theatre of war, the author proposes the scheme of defence which he thinks most likely to save the Turkish Empire, and in doing so he goes somewhat beyond his theme, descending into the plains and discussing the merits and demerits of the line of the Danube as a first position. We need not follow him to the river, but we may suppose, as he does eventually, that a Russian Army has crossed it to the west of Rustchuk. He goes on to observe—

“In making a strategical movement such as this to break through an enemy’s line, it is necessary, as in all operations of this nature, to proceed with the utmost prudence and energy.

“After crossing the river, the first thing for the invader to do with all possible expedition will be to deploy his forces within the pentagon Bjela, Tirnova, Selvi, Lovatz, and Plevna, occupying these points in force, the right flank resting on the Vid, the left on the Jantra. He should especially fortify Tirnova, which will be of great strategical importance as a base of operations whenever he crosses the Balkan; he will thus be prepared to manœuvre to either flank, east or west, according to the measures taken by the enemy. It is evident that whilst holding such a position the invader may make dashes even across the Balkan without fear of molestation.”

It is interesting to compare this forecast of the Austrian General with the measures carried out shortly after it was written, by the Russians. They did cross the river where he supposed they would, but they did not secure their central position before making their dash across the Balkan. Consequently they met with a severe check, and endangered the success of the campaign. Von Kuhn supposes the main body of the Turkish Army to be occupying the Quadrilateral, Silistria, Varna, Schumla, Rustchuk, thus flanking the line of advance of the Russian Army. This seems to be the best position for an active defence of the Balkan, and this was, as we all know, that actually occupied in 1877.

Had this position been used to the best advantage, and had the resources at the disposal of the Turkish Generals been properly employed, it is highly improbable that any considerable body of

Russian troops would have been seen in Roumelia either in 1877 or in 1878, and it is more than probable that the Russian Army would have spent the winter of 1877-78 north instead of south of the Danube.

This is an interesting topic of discussion for military students, but the subject ceases to have a practical interest, because it is highly unlikely that a Turkish Army will ever again have a chance of defending the line of the Balkan from a position in front of it. The following observations bear upon what is more likely to be the state of things the next time the northern invader advances and the southern defender stands at bay:—

“The defence of the Balkan by occupying a position in rear of it has some very great disadvantages, principally caused by the fact that this mountain range virtually consists of two chains separated from one another by very narrow longitudinal valleys, in which it is difficult to place large bodies of troops. Moreover, there is only one short cross road between the two chains, so that should the defender be broken, he runs the risk of being driven into the somewhat desolate region of the southern chain. If, again, you attempt to defend the line of the Balkan from a position in the Valley of the Maritza between Philippopolis and Adrianople, you can hardly hope to make good your defence, at any rate of the foremost range, on account of its distance from you. But when once the invader has made good his passage over it, and has concentrated his forces in the intermediate valleys about Kalofer and Kazanlik, &c., he will have no great difficulty in forcing his way over the second lower ridge. Both chains being thus in possession of the invader, the fate of Turkey will depend upon the doubtful result of a general engagement in the valley of the Maritza The loss of this battle would place Constantinople, the invader's main objective, in imminent danger, and I do not think that this city, to whose geographical position as affecting the world in general many people are still inclined to attach undue importance, would, notwithstanding its defensible site, long withstand the siege artillery of the present day. It appears evident from the foregoing that the defence of the Balkan against an army coming from the north can only be conducted with any hope of success by occupying the Bulgarian quadrilateral, and this is sufficient evidence of the value of this position in front of the mountain range.”

Von Kuhn gives some valuable and interesting instructions upon the distribution of a force which is defending a chain of mountains, both in the case of a position in front and in that of one in rear of it. The chief points to be attended to are—the utmost possible concentration on the main line or lines of operation; the occupation of secondary lines only in sufficient strength to delay the enemy should he attempt to use them; the maintenance of secure communication between the different lines of operation; the occupation of a good base line well in rear of the position, and, as far as possible, parallel to it; the fortification of the points of intersection between the lines of operation and the base, at which points supply depôts should be established.

In some cases, however, the line to be held is of such a nature or extent that the defending force must necessarily be divided into two separate commands. This will be the case when the "flanks of the" position are more than from five to six marches from the centre;" or secondly, when "a very high impenetrable tract of country occupies" the centre or about the centre of the chain, dividing the mountain "region into two distinct sections."

This will, of course, necessitate the formation of two *corps d'armée*, each of which will hold its section of the chain in the manner above noticed.

It will at once strike the English reader that both the above-mentioned conditions apply to the case of our Indian frontier, which has lately so much occupied our attention, and which probably will, sooner or later, be the scene of events even more stirring and important than those which have just come to pass.

The extent of the base line, measuring from the Indian end of the Khyber Pass to that of the Bolan, is over 500 miles, and a great portion of the mountainous country between the two passes is impracticable for large bodies of troops. Consequently we require two separate armies for the defence of our frontier—a Bolan army and a Khyber army.

Steam and the electric telegraph have done much towards rendering it possible for a Generalissimo to control the movements of corps many miles away from him, but it does not appear that in the present generation at least science will make such progress as to enable a British Commander-in-Chief to exercise more than a very general influence over the operations of two such widely separated armies as those in question. The Commander of each must therefore, to a great extent, be independent. Each army must have its separate base of supplies, but these bases must be united by good and secure lines of communication, the approaches to which from the rear must be plentiful and good. Railways must be completed to the mouths, at least, of the Bolan and Khyber.

The general opinion amongst those who have studied the subject is now, I think, that the great range which divides the British possessions from Afghanistan can be best guarded from positions in front of it, and there is little reason to doubt that had the author of "Mountain Warfare" turned his attention so far east he would hold the same opinion, although it must be confessed that one at least of the conditions given in his work as necessary to make such a position tenable does not exist.

The readers of this Journal will be conversant with the able arguments brought forward upon this subject by General Hamley in the theatre of the Institution on the 13th December, 1878, and will be able to compare those arguments with the theories and deductions of the Austrian writer. General Hamley indeed was only in favour of an advanced position for the British left wing (the Bolan army), placing it at Candahar and advocating refusing the right wing, that is, keeping the Khyber army in rear of the passes.

An intermediate course has for the present been adopted, but I have

little doubt that when serious danger threatens, the army of the Bolan will advance to Candahar, and that of the Khyber to Cabul or its neighbourhood, where each army will be most favourably situated for that "defensive-offensive" action which the writer of the work under notice so strongly, and I believe so justly, favours.¹

Meanwhile while holding our present position we can turn our attention to the complete conciliation or subjugation of the mountain tribes, the hostility of which would render an advanced position hardly tenable if seriously threatened, and would oblige us to withdraw our line of defence in rear of the mountains—a proceeding if possible to be avoided.—L. G.

Studies on Military Transport. By Brevet-Major G. A. FURSE, 42nd Royal Highland Regiment. Published by Cockburn's United Service Agency Society. London, 1878. Size 9" x 6". Pp. 223. Weight 9½ oz. Price 2s.

"EVERY Officer acquainted with our military history cannot fail to have remarked the continual recurrence of our small wars and expeditions; these demand a special education for our Officers and an organization suitable for small armies serving principally in uncivilized countries. In these the transport becomes a point demanding particular attention, for we must bear in mind that, in most of these expeditions, we move the best fed and cared for troops in Europe, in countries far from home, in trying climates, over bad roads, and across unproductive districts."

Major Furse wrote the passage which has just been quoted before we engaged in the last two of our "small wars," to which, however, his words are fully as applicable as to any of those which preceded them.

The transport difficulty has cropped up again, as badly as ever, both in Afghanistan and Zululand.

Indeed, in both these countries, as in all those in which we wage "small wars," our principal difficulty is not to defeat the enemy, but to get at him. To enable our armies to do this, on the best possible terms and with the least expenditure of men, money, and time, it is necessary that the special nature and circumstances of every country in which English troops are likely to be engaged should be carefully studied, so that the description of transport best suited to each country should be determined upon beforehand. In colonies such as those in North America, in South Africa, and in New Zealand, the nucleus of a suitable transport corps should at all times be maintained, provision at the same time being made for rapid and sufficient expansion in case of need.

Both in India and at home the necessity for such a state of preparation has been recognized, but in both countries much remains to be done before our transport arrangements can be considered satisfactory. The study of this question is one of the most important and of the most interesting which can occupy the mind of a military administrator.

The little work before us contains, in small compass, a very large amount of information, together with many valuable suggestions, and we confidently recommend it to our readers.—L. G.

¹ The foregoing remarks were written in August, 1879.

